PB81-213282

The University of Akron Urban Air Pollution and Human Health Study

Akron Univ., OH

Prepared for

Health Effects Research Lab.
Cincinnati, OH

Jun 81

U.S. Department of Commerce
National Technical Information Service
NTIS.

EPA 600/1-81-050
June 1981

PB81-213282

THE UNIVERSITY OF AKRON
URBAN AIR POLLUTION AND HUMAN HEALTH STUDY

by

Richard A. Mostardi, Daniel L. Ely,
Nancy Woebkenberg, Mary Conlon, Marcia Jarrett,
and Glenn Atwood
The University of Akron
Akron, Ohio 44325

Grant 804526-01,02

Project Officer
Wilson B. Riggan
Human Studies Division
Health Effects Research Laboratory
Research Triangle Park, North Carolina 27711

HEALTH EFFECTS RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

PRODUCT OF:
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-600/1-81-050	2. ORD Report	3. RECIPIENT'S ACCESSION NO. PB81 21328 2
4. TITLE AND SUBTITLE THE UNIVERSITY OF AKRON URBAN AIR POLLUTION AND HUMAN HEALTH STUDY		5. REPORT DATE June 1981 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) R.A. Mostardi, D.L. Ely, N. Woebkenberg, M. Conlon, M. Jarrett, and G. Atwood		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS University of Akron Akron, Ohio 44325		10. PROGRAM ELEMENT NO. CAGA1D 11. CONTRACT/GRANT NO. Grant 804526-01,02
12. SPONSORING AGENCY NAME AND ADDRESS Health Effects Research Laboratory RTP, NC Office of Research and Development U.S. Environmental Protection Agency Research Triangle Park, NC 27711		13. TYPE OF REPORT AND PERIOD COVERED 14. SPONSORING AGENCY CODE EPA-600/11

15. SUPPLEMENTARY NOTES

Project Officer: Wilson B. Riggan

16. ABSTRACT

Approximately 350 volunteers from East Cleveland, Ohio and 320 counterparts from Elyria, Ohio were studied for the chronic effects of air pollution. The East Cleveland area was chosen for its proximity to heavy industrial air pollution, and Elyria, because it is an urban area with an excellent past record for air quality.

Air quality was monitored by two aerometric stations in each city using total suspended particulates, suspended sulfate, suspended nitrate, sulfur dioxide, and nitrogen dioxide as criteria.

The results of this study indicate that there are some significant differences in the young age groups for lung function tests and questionnaire responses which favor Elyria residents. Differences are also found in the older age groups, and while not as significant, favor the Cleveland residents. These results have many ramifications, the more obvious being that there is some selective migration associated with the Cleveland study area. It would appear that there may be an air pollution effecton the younger volunteers but more detailed study would be necessary for more definitive conclusions.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

18. DISTRIBUTION STATEMENT RELEASE TO PUBLIC	19. SECURITY CLASS *(This Report)* UNCLASSIFIED	21. NO. OF PAGES 165
	20. SECURITY CLASS *(This page)* UNCLASSIFIED	22. PRICE

EPA Form 2220-1 (9-73)

DISCLAIMER

This report has been reviewed by the Health Effects Research Laboratory, U.S. Environmental Protection Agency, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of trade names or commercial products constiture endorsement or recommendation for use.

FOREWORD

The many benefits of our modern, developing, industrial society are accompanied by certain hazards. Careful assessment of the relative risk of existing and new man-made environmental hazards is necessary for the establishment of sound regulatory policy. These regulations serve to enhance the quality of our environment in order to promote the public health and welfare and the productive capacity of our Nation's population.

The Health Effects Research Laboratory, Research Triangle Park, conducts a coordinated environmental health research program in toxicology, epidemiology, and clinical studies using human volunteer subjects. These studies address problems in air pollution, non-ionizing radiation, environmental carcinogenesis and the toxicology of pesticides as well as other chemical pollutants. The Laboratory participates in the development and revision of air quality criteria documents on pollutants for which national ambient air quality standards exist or are proposed, provides the data for registration of new pesticides or proposed suspension of those already in use, conducts research on hazardous and toxic materials, and is primarily responsible for providing the health basis for non-ionizing radiation standards. Direct support to the regulatory function of the Agency is provided in the form of expert testimony and preparation of affidavits as well as expert advice to the Administrator to assure the adequacy of health care and surveillance of persons having suffered imminent and substantial endangerment of their health.

This study covers two populations with divergent levels of air pollution in Northeastern Ohio. One, East Cleveland, has a diverse, highly concentrated industrial area with large populations of permanent residents east and downwind. These residents are chronically exposed to this vast variety of airborne pollutants which singly or in synergistic combination have been shown to be hazardous to health of both animals and humans. The other, Elyria is relatively industry-free with prevaling winds from the west which is predominately farmland. Elyria has such low levels of pollution, it serves as an excellant control community. This study combines physiologic measurements with epedemiologic questionnaire data.

Health Effects Research Laboratory
Director,
F. Gordon Hueter, Ph.D.

Abstract

Approximately 350 volunteers from East Cleveland, Ohio and 320 counterparts from Elyria, Ohio were studied for the chronic effects of air pollution. The East Cleveland area was chosen for its proximity to heavy industrial air pollution, and Elyria, because it is an urban area with an excellent past record for air quality. All of the subjects were recruited by newspaper coverage, radio broadcasts, and word of mouth and the study was conducted identically in both cities.

Each volunteer submitted to pulmonary function tests; electrocardiogram at rest, exercise, and post exercise; trace element analysis in hair, blood, and urine; carboxyhemoglobin, methemoglobin and hormone assay in blood; and were asked to complete two epidemiological questionnaires.

During the duration of the work, air quality was monitored by two aerometric stations in each city using total suspended particulates (TSP), suspended sulfate (SO_4), suspended nitrate (NO_3), sulfur dioxide (SO_2), and nitrogen dioxide (NO_2) as criteria.

The results of this work indicates that there are significant aerometric differences between the two cities for TSP, the respirable and nonrespirable fractions and NO_2, with Cleveland having the higher mean values.

The questionnaire data indicates that the young groups (18-35 males and females) had higher relative risk ratios (RRR) in Cleveland for a given question while the older groups (51-75 males and females) the RRR's indicate no differences in questionnaire responses. Syndromes which were developed from multiple questionnaire items indicate that cough-phlem, shortness of breath, and wheeze syndromes are more prevalent in Cleveland than Elyria, but the airway obstructive and chronic obstructive syndromes were identical.

Lung function studies between the two cities indicate that in general lung functions are lower in the younger age groups in Cleveland but in the older age groups the tendency tended towards lower values in Elyria.

The blood data for COHb showed the usual smoking differences and for both smokers and nonsmokers the mean COHb values were higher in Cleveland. METHb was higher in Elyria and was traced to elevated nitrate in the city water supply. Trace metals in blood and hair did not show any abnormalities.

The results of this study indicate that there are some significant differences in the young age groups for lung function tests and questionnaire responses which favor Elyria residents. Differences are also found in the older age groups, and while not as significant, favor the Cleveland residents. These results have many ramifications, the more obvious being that there is some selective migration associated with the Cleveland study area. It would appear that in the younger years there is an air pollution effect on the respiratory system but these people have a tendency to move out of the area leaving those people who are not as susceptible.

The ECG's of the Cleveland and Elyria subjects were coded at rest, during exercise and post exercise using the Minnesota code (Scandanavian Committee..., 1967) and two coders.

Cleveland subjects showed significantly more A-V conduction defects ($p < .001$) and miscellaneous changes ($p < .0001$) as compared to Elyria subjects at rest and immediately post exercise. During exercise Cleveland subjects showed more S-T depressions ($p < .005$), A-V conduction defects ($p < .05$) and miscellaneous changes ($p < .05$) as compared to Elyria subjects. However, Elyria subjects did show more axis deviation changes ($p < .05$) as compared to Cleveland subjects both at rest and exercise. The changes seen 3 minutes post exercise were essentially the same as those observed immediately after exercise.

When each of the above analyses was performed by comparing age matched groups in the cities by sex, much of the statistical significance disappeared. However, Cleveland females (< 35 yr) still showed more S-T depressions during exercise than their Elyria counterparts ($p < .02$). Cleveland males (< 35 yr) showed more S-T elevations and females (51-75 yrs) more low amplitude P and QRS waves as compared to their Elyria counterparts.

There was not any well defined trend between ECG changes and the extent of smoking, although there were a few spurious increases in ECG abnormalities associated with the highest smoking category.

The most consistent city difference found was that Cleveland subjects had higher A-V conduction defects before, during, and after exercise.

Contents

Forward.. iii

Abstract.. iv

Figures.. ix

Tables.. x

Acknowledgments.. xii

1. Introduction.................................... 1

2. Conclusions.................................... 5

3. Recommendations.................................... 7

4. Methods and Materials.................................... 8

5. Experimental Procedures.................................... 21

    Site Selection.................................... 21

    Subject Recruitment.................................... 21

    Field Procedure.................................... 24

    Health Data.................................... 33

    Statistical Procedure.................................... 41

    Pulmonary Function Testing.................................... 43

    Electrocardiogram.................................... 44

6. Results and Discussion.................................... 45

    Aerometrics.................................... 45

    Health Data.................................... 57

Appendices.. 114

References.. 146

Figures

Figure 1. Schematic of PFT apparatus.

Figure 2. Example of flow volume curves.

Figure 3. System block diagram.

Figure 4. Schematic wiring diagram for connecting the ROM to KIM-1 Microprocessor.

Figure 5. Schematic for A/D converter to KIM-1 Microprocessor.

Figure 6. Buffer amplifier used to feed A/D converters and A/D connections for A/D converter to the KIM-1 Microprocessor.

Figure 7. Geographic locations of aerometric stations in Cleveland, OH.

Figure 8. Geographic locations of aerometric stations in Elyria, OH.

Figure 9. Monthly mean values for total suspended particles (TSP) (1977-78).

Figure 10. Monthly mean values for nitrogen dioxide (1977-78).

Figure 11. Monthly mean values for sulfur dioxide (1977-78).

Figure 12. Monthly mean values for sulfur dioxide (1979).

Figure 13. Monthly mean values for nitrogen dioxide (1979).

Figure 14. Monthly mean values for total suspended particles (1979).

Figure 15. Monthly mean values for nonrespirable suspended particles (1979).

Figure 16. Monthly mean values for respirable suspended particles (1979).

Tables

Table 1. Calibration constants A_0 and A_1.

Table 2. Calibration constants A, B, and C used in SO_2 and NO_2 calculations.

Table 3. Summary of quality control sample analyses.

Table 4. Results of quality assurance sample analyses.

Table 5. Mean aerometric data from November-September 1977-78 in Cleveland-Elyria, OH ($\bar{x} \pm$ SE). Stations 1414 and 1415 are from March-September 1978.

Table 6. Mean aerometric data from February-November 1979 in Cleveland-Elyria, OH ($\bar{x} \pm$ SE).

Table 7. Same day data from station 1412 reported from Cleveland Air Pollution Control System (Clev) and University of Akron study group (AK) ($\bar{x} \pm$ SE).

Table 8. Questionnaire response - adults from Cleveland, Ohio.

Table 9. Questionnaire response - adults from Elyria, Ohio.

Table 10. Age and sex distribution of residents completing the questionnaire and participating in PFT.

Table 11. Relative Risk Ratios (RRR) and levels of probability for questionnaire response in Cleveland and Elyria, Ohio (RRR = $\frac{\text{RR Cleveland}}{\text{RR Elyria}}$).

Table 12. Relative Risk Ratios (RRR) and probability levels for syndromes as described in the text. (RRR = $\frac{\text{RR Clev.}}{\text{RR Elyria}}$).

Table 13. Multiple Regression Summary for Females 18-35.

Table 14. Multiple Regression Summary for Males 18-35.

Table 15. Multiple Regression Summary for Males 36-50.

Table 16. Multiple Regression Summary for Females 36-50.

Table 17. Multiple Regression Summary for Males 51-75.

Table 18. Multiple Regression Summary for Females 51-75.

Table 19. Methemoglobin and carboxyhemoglobin for smoking and nonsmoking males and females in Cleveland and Elyria, OH ($\bar{x}$ ± SE). Units are in % saturation of hemoglobin.

Table 20. Trace elements in hair from selected volunteers in Cleveland and Elyria, OH ($\bar{x}$ ± SE).

Table 21. Trace elements in blood from selected volunteers in Cleveland and Elyria, OH ($\bar{x}$ ± SE).

Table 22. ECG coding reliability measured in the percentage of cases positive for a specific ECG category.

Table 23. Age, height, and weight of males and females in Cleveland and Elyria, OH ($\bar{x}$ ± SD).

Table 24. Percentage usage of various drugs in the Elyria and Cleveland populations.

Table 25. Total listing of variables used in discriminant and multiple regression analyses on pulmonary functions.

Table 26. Wilks discriminant analysis for the males and females 18-35 years from Cleveland and Elyria combined.

Table 27. Wilks discriminant analysis for the males and females 36-50 years from Cleveland and Elyria combined.

Table 28. Wilks discriminant analysis for the males and females 51-75 years from Cleveland and Elyria combined.

Acknowledgments

The authors are grateful to the United States Environmental Protection Agency for the opportunity to conduct a study of this magnitude. Their confidence in us was most gratifying. We are especially grateful to Dr. Wilson Riggan and Mr. Dick Dickerson for professional and personal assistance during this work.

Michael Lebowitz, Ph.D., served as a consultant for this project and his help and guidance in statistics and design were fundamental to its completion.

Most importantly we would like to thank the participants in this study. They gave of their time, provided us with encouragement, and made the implementation of this large and difficult project possible.

TYPING GUIDE SHEET
BEGIN FIRST LINE OF TEXT HERE
CENTER OF PAGE
TOP OF IMAGE AREA
DROPPED HEAD BEGIN SECTIONS HERE

Section 1

Introduction

Air pollution and its effects on human health have been a major concern of the scientific community for many years. The problem now seems to have been intensified in many areas of the United States as high sulfur coal, in its abundance, assumes a major role in energy production. Unfortunately, the release of sulfur containing compounds and suspended particulates is associated with the use of this natural resource, both of which either singly or in combinations have been shown to affect human health. The pressing question is, do sulfur oxides, suspended particulates, and perhaps nitrogen dioxide produce respiratory exacerbation and promote chronic obstructive respiratory disease (CORD) and if so what are the associated critical levels or concentrations?

Many studies conducted throughout the world have indicated that there is a strong relationship between reduced pulmonary function, CORD, and the sulfur oxide/particulate complex in adult populations (1-8). Other studies, however, have not shown such a strong relationship and suggest that the effects do not exist or are casual (9-12). The reason for such varied and divergent findings in studies dealing with CORD are many but could include the following: 1) population mortality -

BEGIN LAST LINE OF TEXT
BOTTOM OF IMAGE AREA OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
PAGE NUMBER

deaths in the study area associated with lung disorders, especially carcinomas and emphysema would preclude participation in the study; 2) population morbidity - more than likely, people suffering from CORD will leave the areas of high pollution either of their own recognizance or on the advice of a physician. This also precludes participation in a study of this type; 3) subject fear - many people will not volunteer for epidemiological studies of this type because they are aware of the hazards with air pollution, or may have a physical problem and are reluctant to have it diagnosed; 4) association with air pollution - people living adjacent to industrial complexes often work there or have relatives who work there. Therefore, these people will not volunteer for participation in air pollution studies because it is a controversial subject and generally feel that industry should not be subjected to more rigid pollution control legislation and enforcement; 5) acute variations in air pollutants - variations in the levels of air pollution can affect pulmonary function tests. Excessively high or low levels of air pollutants during or several days prior to pulmonary function testing can exert a considerable bias on single test, cross sectional study. Such effects must be monitored very closely; 6) variations in levels and types of pollution and meteorology - photochemical pollution problems are significantly different from sulfur oxide/particulate pollution and studies conducted in one environment are difficult to compare with those done in another; 7) people who live in a heavily polluted area frequently leave for extended periods of time during a given day. Many people also are employed outside of the residential area. Therefore, they are only exposed for a portion of the day which could exert considerable effects on epidemiological studies; 8) lack of standardization in data collection - different authors conduct differing lung function tests and causing study comparisons to be difficult. Furthermore, some of the work is conducted with new or unique tests which do not withstand retesting and again are of limited value.

Two cities or parts of cities were selected for this study, one with high levels of industrial air pollution, the other with comparably low levels. The purpose of this work was to compare the measured air and health parameters on volunteer populations in these two cities. Of particular interest were the more chronic health effects. By measuring the air quality and determining pollution types and levels in the immediate area of the exposed populations and comparing these levels with standard, well-tested epidemiological methods it was felt that more definitive assessments of any observed health effects could be made.

In addition to the above air pollution study a hypertension substudy was conducted. Five hormonal and three behavioral measures were examined in a select subpopulation of the air pollution study population. These data, however, will not be reported here but in another EPA report.

Section 2

Conclusions

Aerometric data between the two cities (Cleveland and Elyria) for the year 1977-78 did show some significant differences for SO_2 and NO_2. However, the values reported from each city were not abnormally high. For the year, 1979, TSP and the respirable and nonrespirable fractions along with NO_2 showed significant differences. In each of the years the Cleveland stations recorded the highest values for each of the variables.

The results of the data on the resident populations indicate that the young males and females (18-35) in Cleveland reported more chronic respiratory symptoms and showed a reduction in lung function efficiency indicated by pulmonary function testing. The older populations of males and females (50-75) were nearly identical with respect to reporting chronic respiratory symptoms but the older males and females in Elyria showed a tendency for reduced lung efficiency. On the basis of these results we suggest that a migration of the more susceptible individuals out of Cleveland is influencing the data and accounts for the observed differences.

Trace metal data between the two cities were similar and none of the mean values were abnormally high.

Carboxyhemoglobin (COHb) and methemoglobin (MetHb) data showed some interesting differences. COHb was significantly higher in both smokers and nonsmokers in Cleveland and is likely due to the heavy automobile traffic. MetHb was significantly higher in Elyria and was attributed to higher nitrate levels in the city water supply. COHb showed the usual smoking effects in both males and females in both cities.

The results of the ECG tests were subtle when the populations were broken down into age and sex groups. The most consistent between city differences was that the Cleveland subjects had higher A-V conduction defects before, during, and after exercise.

Section 3

Recommendations

Specific recommendations resulting from these data would be difficult to make. It is felt that the study of the chronic effects of air pollution through the testing of volunteers one time permits limited statistical interpretation. More effective, would be evaluating the volunteers several times each year over the course of many years so that subtle trends could be more effectively identified. Such studies would require 10-20 years of study and would prove to be quite expensive.

The data collected in this study does effectively separate the populations between Cleveland and Elyria as a function of age; the questionnaire data as well as the pulmonary function data corroborate this. Whether or not these effects can be attributed directly to air quality cannot be determined at this time. It does appear, however, that selective migration of the populations could be in operation and contributing to the observed results.

Section 4

Methods and Materials

The development of four methods and one piece of equipment were essential to the completion of this work. In this section each will be described in detail.

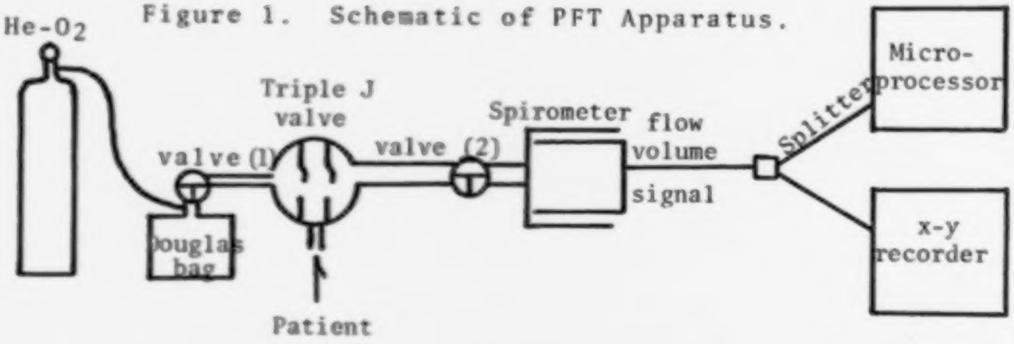
Methods

Flow Volume Curves Helium-Oxygen (80%-20%) -

There is considerable information in the literature suggesting that maximal expiratory flow volume (MEFV) curves using air and a helium-oxygen mixture (80%-20%) can provide more descriptive information concerning the condition of the small airways than forced expiratory volume (FEV_t) or maximal midexpiratory flow (MMF) (13, 14, 15). For this reason we have established MEFV curves as an important parameter of lung function in this study.

A schematic drawing of the equipment configuration is shown in Figure 1 and data collection involves the following steps. The subject is seated comfortably so that the mouth is directly in front of a Collins Triple J valve with attached mouthpiece. The subject is verbally instructed as to how a forced expiratory maneuver is performed, which is then followed by a demonstration by the experiment. Then the subject attempts several trial maneuvers attached to the mouthpiece and with a nose clip in place. When the experimenter is satisfied that the maneuver is being performed adequately, the expired air is directed into a Cardio-pulmonary Instrument (CPI) dry rolling seal spirometer, and three forced expiration efforts are recorded on a CPI model 750 x-y recorder. The expired air is diverted into the spirometer by turning valve 2. When three similar curves are recorded using room air, the same procedure is followed using the He-O_2 mixture.

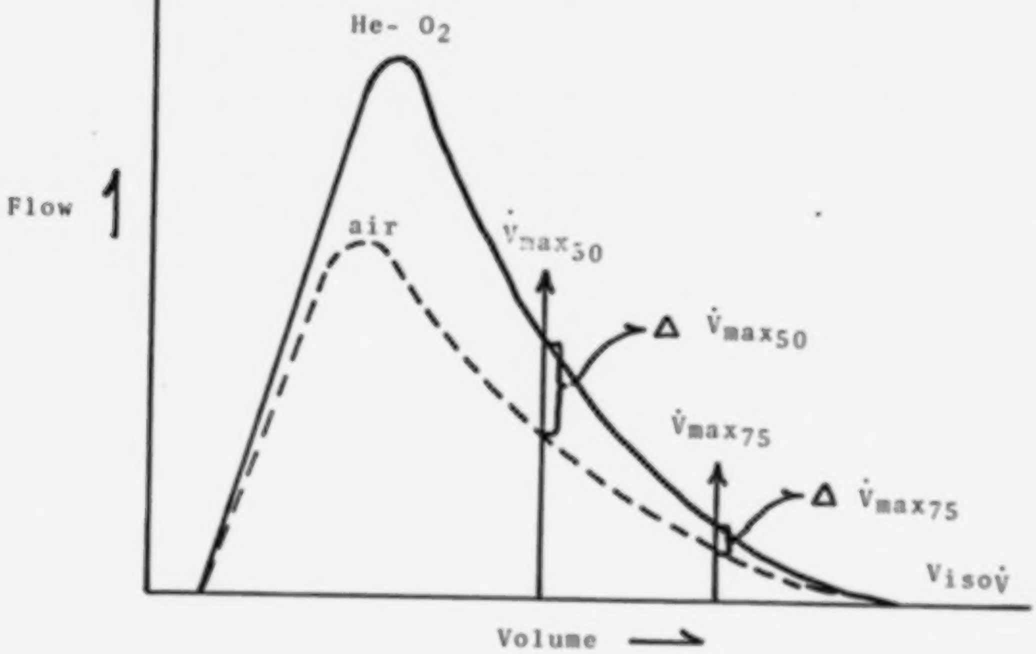
Figure 1. Schematic of PFT Apparatus.


He-O_2
Triple J valve
valve (1)
valve (2)
Spirometer
flow volume signal
Splitter
Micro-processor
x-y recorder
Douglas bag
Patient

Prior to breathing the He-O_2 mixture, the subject is taken off the mouthpiece and receives a brief description of the gas mixture, notably that the mixture is somewhat cooler than the room air and the only thing that we are doing is replacing the nitrogen normally found in the air by another gas. Following the explanation, the subject is reconnected to the mouthpiece with the nose clip attached and then, by turning valve 1, the subject breathes the He-O_2 mixture out of the 200 litter Douglas bag. To displace the N_2 in the lungs, the subject performs three forced vital capacity (FVC) maneuvers with several tidal breaths in between. Following equilibration with the He-O_2 mixture the subject performs three satisfactory forced expiratory maneuvers with the curves being recorded as before.

Analysis of these curves is carried out according to the previously described method of Antic and Macklem (14). This involves superimposing the curves for air and He-O_2 at total lung volume (TLC). The best FVC on air is used to define the volumes at which $\dot{V}_{max}$ is measured. Thus the 50% and 75% expired FVC volumes from the best air FVC is used to determine air flow at 50% of FVC ($\dot{V}_{max50\%}$) and flow at 75% of FVC ($\dot{V}_{max75\%}$) from all curves. The values $\Delta\dot{V}_{max50\%}$ and $\Delta\dot{V}_{max75\%}$ are calculated as the difference between the air and He-O_2 curves and expressed as a percentage of the total volume on air at the point. The volume at isoflow, ($V_{iso\dot{V}}$) is the point at which there is clear crossing or merging of the air and He-O_2 curves as opposed to an apparent converging. Figure 2 graphically shows how these flows are determined.

Figure 2. Example of flow volume curves.



Carboxyhemoglobin (COHb) and Methemoglobin (MetHb) -

Carboxyhemoglobin analyses were performed on whole blood using EDTA as an anticoagulant on a Co-Oximeter 182. This method utilizes the fact that carboxyhemoglobin has a unique absorption spectrum. A change in absorbance at 568 nm compared to the absorbance at 548 nm indicates a change in the relative concentration of carboxyhemoglobin. The amount of change in absorbance is entered into the Co-Oximeter's electronic computational matrix and allows presentation of the carboxyhemoglobin concentration. The machine is calibrated with human blood saturated with 100% carbon monoxide gas.

Methemoglobin determinations were also performed on whole blood according to a modification of the method of Hainline (16). This spectrophotometric method is based on the maximum absorbance of methemoglobin at 630 nm. Actual absorbance readings were taken at 620 nm. At this wavelength the methemoglobin absorbance does not vary with pH. Cyanide was then added to convert the methemoglobin to cyanmethemoglobin which absorbs insignificantly at 620 nm. The difference of the two readings is proportional to the concentration of methemoglobin. The blood was diluted with a triton-borate solution, and absorbances read on a Spectronic 70 spectrophotometer. In order to express methemoglobin as a percent of total hemoglobin, the total hemoglobin was determined by the cyanmethemoglobin method utilizing Hycel reagents (Hycel, Inc., Houston, Texas).

Hormonal Measurement (Hypertension substudy) -

Plasma catecholamines, renin, and cortisol were determined by the following methods. The catecholamines were measured using the radioenzymatic assay kit developed by Upjohn Diagnostics (CAT-A-KIT). This technique allows determinations of norepinephrine, epinephrine, and dopamine in plasma using 50 ul samples. The basic technique utilizes the enzyme catechol-O-methyl-transferase (COMT) to catalyze the transfer of a 3H-methyl group from S-adenosyl-L-methionine to norepinephrine and epinephrine. The resulting products are isolated by thin layer chromotography. Each labeled derivative is converted by periodate oxidation to 3H-vanillin and extracted. The radioactivity of each catecholamine is determined by scintillation counting. The use of this technique has been reported by Peuler and Johnson (17).

Plasma renin activity was measured by an angiotensin I immunokit provided by New England Nuclear (No. Billerica, Mass.). Under the conditions of this assay the accumulation of angiotensin I is favored by allowing endogenous renin and substrate to react in the presence of reagents which inhibit both plasma coverting enzymes and proteolysis by angiotensinases. The New England Nuclear (NEN) Angiotensin I RIA kit is based on an adaptation of this method. The conditions of assay have been designed to favor the generation of angiotensin I by plasma renin in a system buffered within its pH optimum, 5.5-6.0, in the presence of suitable inhibitors (18).

Cortisol levels were determined by radio-immuno assay using the Clinical Assays, Inc., cortisol kit (Cambridge, Mass.). The procedure is based on competitive binding principles involving incubation in an antibody coated tube and the contents of the tube are then aspirated and then counted and plotted against a standard curve (19).

Trace Element Analysis in Blood -

Blood mercury (Hg) was analyzed on a MHS-10 Hydride Generation System utilized in conjunction with Model 460 Atomic

Absorption Spectrophotometer (Perkin-Elmer Corp., Norwalk, Conn.). This is a cold vapor technique in which the sample solution is first treated so that Hg is present in ionic form in an acid solution. With the addition of sodium borohydride as a reducing agent, Hg is reduced to its metallic state. Since Hg vaporizes at a relatively low temperature, Hg vapor is formed and is swept, by means of an argon purge, out of the sample solution, and into a quartz cell where its absorption is measured, producing a peak signal, the height of which is proportional to the amount of mercury in the sample when compared to known standards. Before analysis the blood was oxidatively digested overnight by the addition of 5 ml ultrex grade 70% nitric acid (J.T. Baker Co., Phillipsburg, NJ), and 2 ml 5% potassium persulfate.

Blood lead was determined by atomic absorption spectrophotometry utilizing a model 460 Atomic Absorption Spectrophotometer and a model 2200 Graphite Furnace (Perkin-Elmer Co., Norwalk, Conn.). In an atomic absorption system free ground state atoms enter into an excited state by absorbing a very specific wavelength of light which is particular for each element. The amount of light absorbed as it passes through a group of atoms is measured by the spectrophotometer. The graphite furnace is used to apply heat to the sample solution which serves to dissociate the sample chemical compounds into free atoms thus enabling the atoms to absorb light.

For analysis, the blood was diluted 1:5 with scintillation grade Triton-x-100 (Mallenkrodt Inc., St. Louis, Missouri).

Materials

Microprocessor for PFT -

The microprocessor used for lung function testing was developed and tested in our laboratory prior to field use.

The system consists of KIM-1 Microprocessor with 2K read only memory (ROM) and 1K random access memory (RAM), a Datel 12 bit A/D converter, and associated power supplies. The RAM is located between 0 and 3FF and the ROM between 400 and 0C00. The block diagram is shown in Figure 3.

Figures 4 and 5 show the schematic diagrams which were used in connecting the ROM and the A/D converter to the KIM 1. Figure 6 shows both the buffer amplifier used to feed the A/D converter from the spirometer and the A/D connections for the A/D converter to the KIM 1.

The spirometer was connected to an x-y recorder which supplied the reference voltage source to the spirometer potentiometer. This reference source seemed to vary slightly and although it did not affect the response of the chart recorder it did affect the accuracy of the peak readings made by the A/D converter. To obtain increased accuracy a dual potentiometer was used, one for the chart recorder and one for the microprocessor. A separate reference source could then be provided for the microprocessor circuit, being supplied by the A/D converter itself.

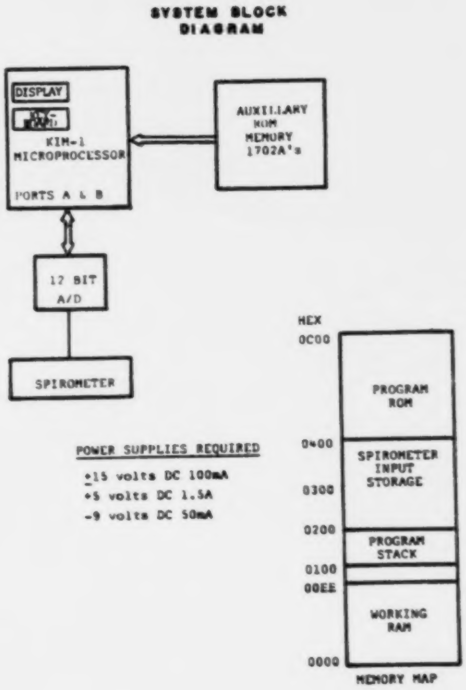

SYSTEM BLOCK DIAGRAM
DISPLAY
KEYBOARD
KIM-1 MICROPROCESSOR
PORTS A & B
AUXILIARY ROM MEMORY 1702A's
12 BIT A/D
SPIROMETER
POWER SUPPLIES REQUIRED
±15 volts DC 100mA
+5 volts DC 1.5A
-9 volts DC 50mA
HEX
0C00
PROGRAM ROM
0400
SPIROMETER INPUT STORAGE
0300
0200
PROGRAM STACK
0100
00EE
WORKING RAM
0000
MEMORY MAP

Figure 3. System block diagram.

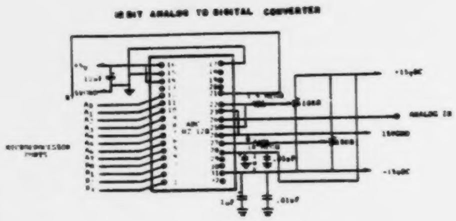
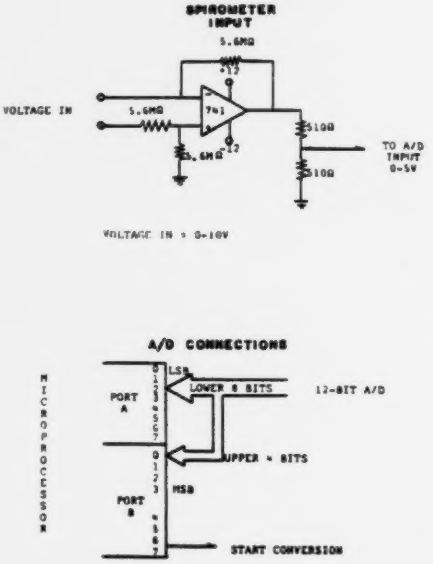

12 BIT ANALOG TO DIGITAL CONVERTER
+15VDC
ANALOG IN
-15VDC
1uF
.01uF

Figure 5. Schematic for A/D converter to KIM-1 Microprocessor.


SPIROMETER INPUT
5.6MΩ
+12
VOLTAGE IN
5.6MΩ
741
-12
5.6MΩ
510Ω
510Ω
TO A/D INPUT 0-5V
VOLTAGE IN = 0-10V
A/D CONNECTIONS
MICROPROCESSOR
PORT A
LSB
LOWER 8 BITS
12-BIT A/D
UPPER 4 BITS
MSB
PORT B
START CONVERSION

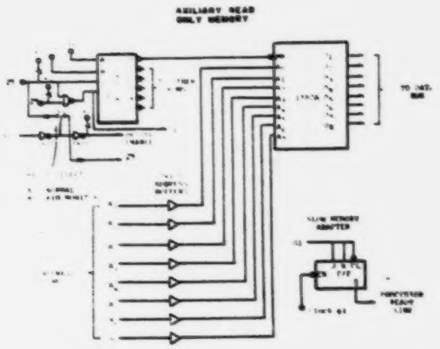

AUXILIARY READ ONLY MEMORY
1702A
TO INT. BUS
SLOW MEMORY ADAPTER

Figure 4. Schematic wiring diagram for connecting the ROM to KIM-1 Microprocessor.

Figure 6. Buffer amplifier used to feed A/D converters and A/D connections for A/D converter to the KIM-1 Microprocessor.

System Program -

The system is programmed on a linear basis. The initialization is performed, followed by data inputs, and finally the calculation of the various values of pulmonary function parameter which are desired. Following are the names of the various subroutines along with their function in the program.

Programs Used in Microprocessor System

MAIN - initializes memory, sets the timing period, calculates: FVC, FEV, mid-max flow, peak flow, and adjusts these values by the spirometer constant. It also calculates a second set of values corrected to body conditions. This routine is entered from "RS" button keyboard.

SETUP - inputs spirometer constant and barometric pressure from the keyboard. This routine is entered from "ST" button on keyboard.

DISPL - subroutine to display prompt words "CONS", "PRES", and "READY" on the display.

INP - subroutine to input values from the keyboard and display them on the display.

STORE - subroutine which stores initial spirometer volume, pauses until the volume increases beyond a threshold, then stores 50 spirometer values per second by calling AVERV until the available memory is filled.

AVERV - subroutine which averages 32 samples from the 12 bit analog to digital converter during each 20 millisecond spirometer read period.

TODEC - subroutine to convert 12 bit binary values to decimal values.

COREC - subroutine which calculates a correction constant for a second set of values which are corrected for body conditions.

EX - subroutine which calculates exponential values.

DIV - subroutine which handles decimal divide.

MULT - subroutine which handles decimal multiply.

OUT - routine which moves the answer corresponding to the keyboard button pressed to the display.

The unit determines the vital capacity by measuring the difference between the initial and final values of the volume measurement. The FEV at 1 second is determined from the stored values in the data array by taking the value stored at the end of the first second and subtracting the first value in the array. The mid maximal flow is determined by first calculating the volume at the mid point of the FVC and second determining the slope of the curve at that point. The peak flow is determined by obtaining the maximum difference between successive stored values divided by the time of sampling, 0.02 sec. In 0.02 sec there are 32 determinations of a change in voltage. These 32 values are then averaged and a single value is entered into the data array. The system is capable of 50 such 0.02 sec operations which constitutes a full second. The total memory capability of the system is five seconds.

System Operation -

The keyboard of the KIM-1 Microprocessor is used for control of the system and for data entry purposes. The system is started by passing the ST keyboard button which calls routine SETUP for entering the numerical constant for the particular spirometer being used. The display shows "CONS" requesting the operator to enter the six digit constant. The A/D converter uses a relative voltage reference for conversion and as a result a calibration constant must be entered. This is done to minimize the difference between spirometers and power supplies. We found it convenient to empty a 1 liter syringe into the spirometer and then determine the appropriate constant. For a given spirometer the constant will then remain the same. The display then shows "PRES" and the barometric pressure to the nearest 0.1 mmHg is entered.

The main controlling routine MAIN is then entered automatically and the program first initializes a number of parameters, and then jumps to subroutine STORE which calls AVERV to determine the average value for the time period before storing it in the memory.

The STORE subroutine inputs the first value from the A/D and stores it in memory. The STORE subroutine begins checking for the A/D value to increase beyond a threshold. At the same time, the display routine DISPL is called which displays the word "READY" as an indication to the operator that the subject can begin the test. If the input value decreases, a new FIRST VALUE is stored. When the threshold is passed (i.e., when the subject begins blowing into the spirometer), the subroutine begins to input values from the A/D to AVERV and then stores the average of 32 voltage changes (0.02 sec) at a rate of 50 values per second. When the available memory is full (approximately 250 values which is sufficient for 5 seconds of sampling), a return is executed to the MAIN routine.

The values for FVC, FEV_t, MMF, and PF are calculated from the binary values which have been stored in memory. This uses the subroutines for multiplication, division, and binary to decimal conversion. At this point the numerical constant entered earlier is used to adjust the four calculated values. These values are then moved to an output memory area and the program jumps to the output routine OUT.

After the FVC, FEV_t, MMF, and PF are calculated and stored, the program converts these values to BTPS using the barometric pressure and spirometer temperature which are entered manually, the barometric pressure at the beginning and the spirometer temperature after each spirogram is obtained.

The output routine initially displays the first calculated value and then displays the value corresponding to the last key pressed on the keyboard. By depressing keys 1-4, the ATPS values of FVC, FEV_t, MMF, and PF are displayed, depressing keys 5-8 displays the same variables corrected to BTPS. This routine ignores all keys except 1 through 8.

To make another run, the user simply presses the reset button on the keyboard which branches the program back to the beginning of "MAIN".

Section 5

Experimental Procedures

Site Selections

Northeastern Ohio contains a number of potential sites for air pollution research. East Cleveland, Ohio, was chosen because it contains an industrial area that is large, diverse, and is adjacent to a large permanent population. Figure 7 is a portion of a topographical map showing the geographical boundaries of the study area. People residing only within this area were considered for inclusion in the study. The city of Cleveland (Cleveland Division of Air Pollution Control) has several aerometric stations in this area and reported data indicates that this area, on an annual basis, has some of the highest levels of air pollutants in the state (20).

Elyria, Ohio, was selected using the same principles. Air pollution reported for this urban area (Elyria Division of Air Pollution Control) is the cleanest in Ohio, i.e., values for TSP, SO_2, and NO_2 are well below the Ohio primary levels. Figure 8 is a topographical map showing the geographical boundaries of this area.

Subject Recruitment

In both cities the local newspapers were contacted and a

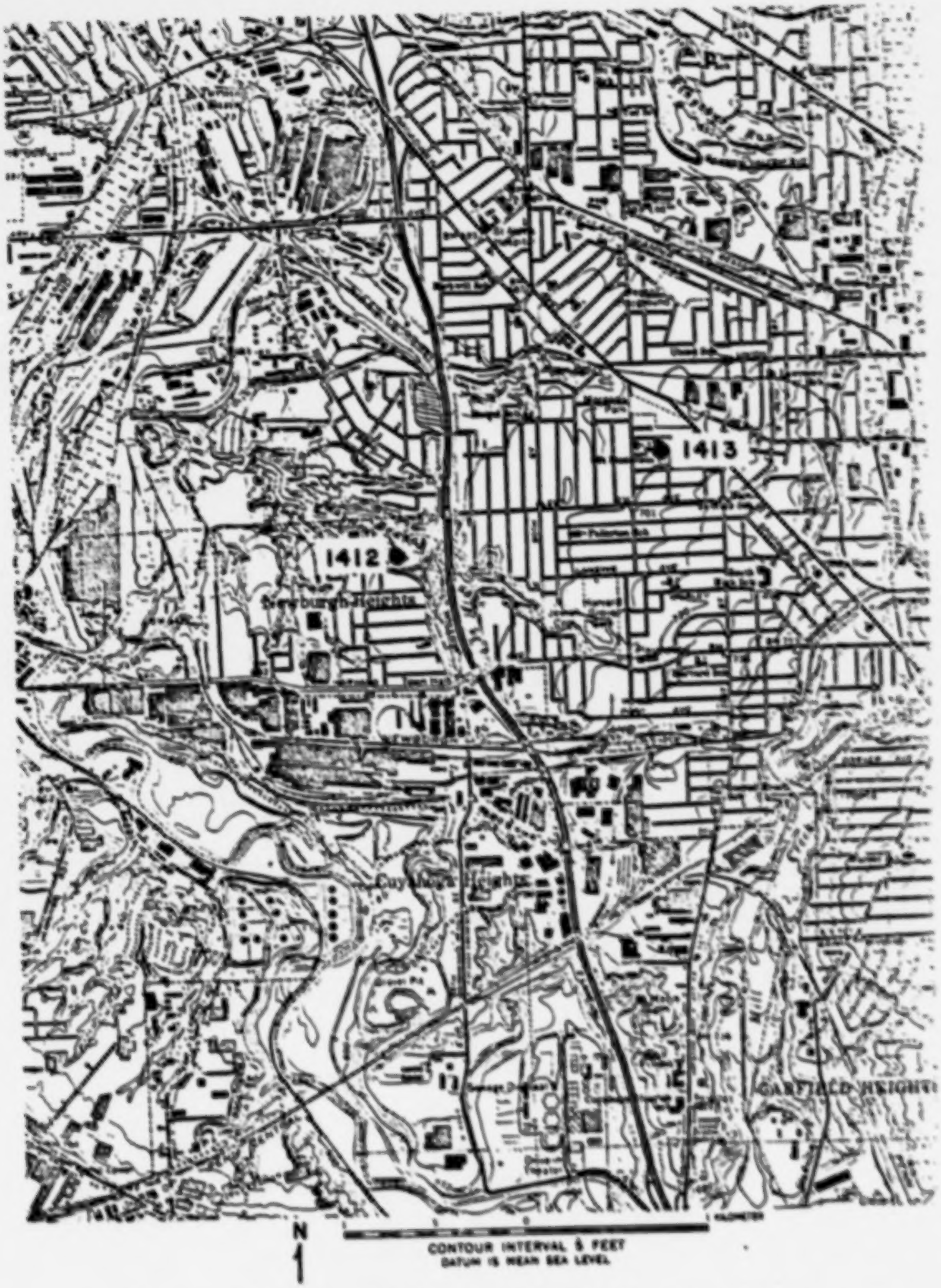

1413
1412
Newburgh Heights
Cuyahoga Heights
GARFIELD HEIGHTS
N
CONTOUR INTERVAL 5 FEET
DATUM IS MEAN SEA LEVEL

Figure 7 - Geographic locations of aerometric stations in Cleveland, OH.

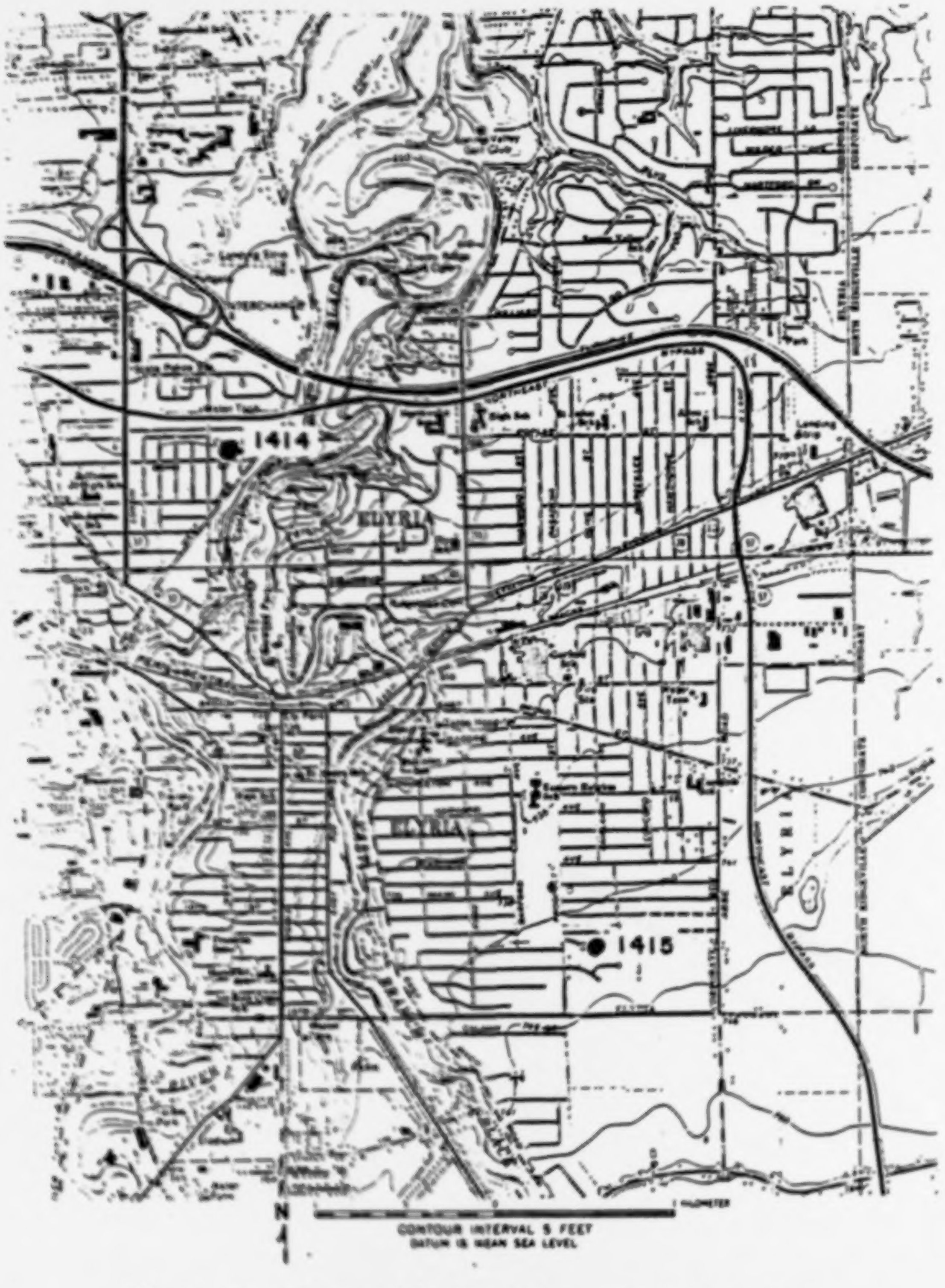

1414
ELYRIA
ELYRIA
1415
N
CONTOUR INTERVAL 5 FEET
DATUM IS MEAN SEA LEVEL

Figure 8 - Geographic locations of aerometric stations in Elyria, OH.

story was run indicating the nature of the research project, the nature of the test administered, the dates and the site for test administration. Radio stations were also contacted and the same information was broadcasted.

The response from the communities was excellent, and there were always more volunteers than could be processed and run through the research protocol.

In the news announcements, the boundaries of the study area were indicated so that residents from outside of the area would not volunteer. This effort was not totally effective as in Cleveland we had over one hundred volunteers from outside of the study area. Most of these people at least worked in the study area so they were run through the protocol but were grouped separately and coded as "OUTS" for comparative purposes. Those living in the study area were coded as "INS". Those people that neither lived nor worked in the study area were still run through the study protocol but were not included in any of the statistical analyses presented in this report.

Field Procedure

Aerometrics -

The aerometric stations were set up in Cleveland and Elyria in December and January of 1977-78. There were two stations in Cleveland, Washington Park (1412) and St. Stanislaus (1413), and two in Elyria, Cascade School (1414) and

Prospect School (1415). Three of the stations 1412, 1414, 1415 were situated on top of a one story roof, and 1413 was at ground level. When the stations were set up in 1977 they consisted of hi-volume samplers for TSP and bubbler trains for SO_2 and NO_2. The stations were operated by trained field technicians on a daily 24 hour basis beginning and ending at 8:00 a.m. The hi-volume samplers and flow meter for each of the sites were calibrated using a Sierra Orifice which was calibrated by the U.S. EPA at Research Triangle Park, NC. Each unit had a Sierra Flow Controller to maintain flow at 1.13 m^3/min (40 cfm). Flow was recorded on Dickson recorders. The filter papers were supplied and weighed by the Community Health Assessment Monitoring Program (CHAMP) subcontractor Stewart Laboratories, Knoxville, Tenn.

The NO_2 and SO_2 samples were collected using liquid phase bubbler train. The absorption solutions were supplied and analyzed by Stewart Laboratories. The bubblers were run for the same 24 hour period as the hi-vol sampler. The flow through the bubbler train was measured using calibrated rotometers both before and after each sampling. The flow through the tube was controlled by use of the critical flow orifice and was about 200 cc/min. After the samples were collected the NO_2 solution was refrigerated and the SO_2 was frozen and shipped to Stewart Laboratories in refrigerated boxes.

During early 1979, Anderson samplers were installed at three sites 1412, 1413, and 1415. At about this same time, 1414 was shut down for two reasons, 1) in anticipation of assuming complete operations of the air monitoring for the project, we closed down this station to reduce the workload, 2) this station was producing data which was quite similar to the adjacent station.

On April 1, 1979, the CHAMP contracts expired and thereafter complete support for the stations was assumed by the research group. As mentioned above, one of the stations was shut down and the remaining stations 1412, 1413, and 1415 were run on alternate days, each operating on the same day. A brief description will be provided concerning the chemistry and internal as well as external quality control (QC) associated with operation of the stations.

Total suspended particulates -

Same lot Gelman Instrument Co. filter paper was provided by the U.S. EPA. Initially each filter was placed on a light box for pinholes and identified by a stamped number. Each paper was then placed in a dessicator (equilibration) and dried for 24 hours. These filters were then removed from the dessicator one by one and weighed on a Mettler H80 4 place analytical balance (Tare weight, gms). The filters were then placed between sheets of 8 1/2 x 11 plain paper and placed in an 8 1/2 x 11 zip lock bag until use at one of the stations. The respirable filters used in the Anderson dichotomous units were the same as those used in the hi-vol units. The nonrespirable filters for the Anderson units were purchased from Anderson Samplers, Inc., and were checked for pinholes, numbered, dried, and weighed as described above. The operation of the field stations was unchanged.

When the filters were removed from the hi-volume units they were folded in half, placed between the two plain sheets of paper and placed in the zip lock bag. The samples were then returned to Akron University where they were again dessicated for 24 hours (equilibration) and then reweighed (Gross wt, gms). The total suspended particulate was calculated as follows.

Particulate weight (grams) was obtained by subtracting Tare Weight from the Gross Weight and time of the run (minutes) was obtained from the Sierra flow controller or from the Dickson recorder which were installed in all hi-volume and Anderson units. The Dickson recorders and the motors installed at a particular site were calibrated using an orifice calibration unit supplied by the U.S. EPA. The calibration is a standard technique, the details of which are provided elsewhere (21). The air flow rate (cubic meters/minute) could then be determined by the following calibration equation:

$$\text{Air flow rate } (m^3/\text{min}) = A_0 + A_1 R \qquad (1)$$

where A_0, A_1 are calibration constants
obtained from a linear regression equation and
R is the reading show on the Dickson Chart Recorder

Flow rates were not integrated from the Dickson recorders because flow rates for these units were very constant for a 24 hour period. If large fluctuations in flow rates did occur then the charts were integrated; this, however, occurred very infrequently.

It should be noted that the calibration constants A_0 and A_1 were different for the hi-volume and Anderson units and were also different for each site (Table 1).

Table 1. Calibration Constants A_0 and A_1

	A_0		A_1	
	Hi-volume	Anderson	Hi-volume	Anderson
1409	-0.1546	0.1402	0.031197	0.028594
1410	0.0371	0.0371	0.03095	0.03095
1412	-0.1843	-0.2392	0.031597	0.033212
1413	-0.0829	-0.1030	0.032429	0.030367
1415	-0.665	-0.1040	0.039909	0.03180

The Total Suspended Particulate (ug/m^3) was obtained from the following equation:

$$\text{TSP (ug/m}^3\text{)} = \frac{\text{Particulate Weight (g)} \times 10^6 \text{ (ug/g)}}{\text{Air flow rate (m}^3\text{/min)} \times \text{Time (min)}} \qquad (2)$$

Sulfur dioxide. Chemical analysis of ambient SO_2 levels was performed by the West-Gaeke colorimetric method, that has been modified and improved by Scaringelli, et al., (22, 23).

At the sampling site SO_2 is absorbed by aspirating a measured volume of air through a solution of potassium tetrachloromercurate (TCM). The TCM contains ethyl EDTA which complexes interfering heavy metals. In the absorbing tubes a stable non-volatile dichlorosulfitomercurate ion is formed. In the laboratory, more TCM is added to a measured aliquot and ozone is allowed to decompose. Sulfamic acid solution is added to destroy nitrite from oxides of nitrogen. The addition of solutions of formaldehyde and purified, acid-bleached pararosaniline (prepared by Eastman Chemicals according to specifications outlined by Scaringelli) leads to the formation of intensely colored pararosaniline methylsulfonic acid. This final preparation is read on a Hitachi-Perkin Elmer Spectrophotometer Model 139 at 548 nm. Since the prepared samples are extremely sensitive to temperatures, they were kept in a refrigerated constant-temperature (20°C) water bath during the color development phase. The cell compartment of the spectrophotometer was also water-cooled with refrigerated water, (20°C).

Nitrogen dioxide. Chemical analysis of NO_2 was done by the arsenite method, the details of which are outlined in the Federal Register (24). At the sampling site NO_2 is collected by bubbling a measured amount of air through an absorbing agent, a solution of sodium hydroxide and sodium arsenite (25). This forms a stable solution of sodium nitrite. In the laboratory the nitrite ion is reacted with a sulfanilamide/phosphoric acid solution and N-1-naphthylethylene diamine dihydrochloride (NEDA) to form an azo dye, the color of which is read at 540 nm. To prevent interference of SO_2 with the azo dye formation, hydrogen peroxide is added to the sample aliquot prior to analysis, thus converting SO_2 to sulfate ions. The samples are also read on a Hitachi-Perkin Elmer Spectrophotometer Model 139 at 548 nm.

Calibration and Calculation for SO_2, NO_2

To ensure the efficiency of each gas absorbing system, permeation studies were carried out for both SO_2 and NO_2 according to the standard procedure (26). NO_2 and SO_2 were calculated as follows.

Since the gas bubbler unit was connected to the hi-volume unit, time of the run (minutes) was the same as that for the hi-volume unit. The air flow rate for the entire period of the run was taken to be the average of the flow rate at the start of the run and the flow rate at the end of the run. The flow rates at the start and the end were measured by a rotameter which was previously calibrated according to the following equation:

$$\text{Air flow rate (cubic centimeters/min)} = A + BX + CX^2$$

where A, B, and C (Table 2) are calibration constants again obtained from a linear regression equation and X is the reading shown by the rotameter

The SO_2 and NO_2 gas concentrations were then obtained from the following equations:

$$SO_2\ (\mu g/m^3) = \frac{\text{Total } SO_2 \text{ content (ug)} \times 10^6\ (cm^3/m^3)}{.9^{*}\ \text{Average air flow rate } (cm^3/\text{min}) \times \text{Time (min)}} \quad (3)$$

$$NO_2\ (ug/m^3) = \frac{\text{Total } NO_2 \text{ content (ug)} \times 10^6\ (cm^3/m^3)}{0.85^{**} \times \text{Average air flow rate } (cm^3/min) \times \text{Time (min)}} \quad (4)$$

*Efficiency factor for the SO_2 absorbing liquid as determined by our permeation studies.

**Efficiency factor for the NO_2 absorbing liquid (recommended by U.S. EPA, (4 NO_2), and also confirmed by our permeation studies.

Table 2. Calibration Constants A, B, and C used in SO_2 and NO_2 calculations.

	A	B	C
1409	8.902265826	5.568985888	0.791915508
1410	7.374974412	2.953656233	0.965860292
1412	12.19480706	4.780826629	0.860054669
1413	7.309853361	4.804050034	0.862194788
1415	7.661661022	3.792451279	0.887045893

Quality control samples for SO_2 and NO_2 were received from the U.S. EPA and were run along with the field samples. Both the known values and the measured values are shown in Table 3.

Table 3. Summary of Quality Control Sample Analyses

SO_2

Sample Level	Samples Analyzed	Outliers	Akron Result (μg SO_2)	True Values (μg SO_2)	C.V.[1]	%Diff.[2]
1	6	1	4.37	3.9	19%	+12
2	15	0	11.67	11.1	16%	+5
3	3	1	26.33	24.0	4%	+10
4	14	0	38.80	37.6	7%	+3
5	13	0	52.41	51.5	4%	+2

NO_2

Sample Level	Samples Analyzed	Outliers	Akron Result (μg NO_2)	True Values (μg NO_2)	C.V.[1]	%Diff.[2]
1000	13	0	12.89	12.7	2.8%	+1.5
2000	3	0	19.82	20.0	1.8%	-0.9
3000	13	0	25.23	25.0	1.9%	+0.9
4000	2	0	34.50	34.5	0.1%	0.0
5000	12	0	46.63	46.3	1.6%	+0.7

[1] $\text{C.V.} = \frac{\text{Akron std. dev.}}{\text{Akron mean}} \times 100$

[2] $\text{\%Diff.} = \frac{\text{Akron mean-true}}{\text{true}} \times 100$

Suspended sulfates and nitrates were subcontracted to Research Triangle Institute (RTI), Research Triangle Park, NC, and the procedure was as follows. After dessicating and weighing the filters from the three stations they were cut in half at right angles to the fold so that the sample was not disturbed. This cut half was placed in a folded slip of 8 1/2 x 11 plain paper placed in a zip lock bag and sent to RTI along with all data associated with the filter. Quality control samples were also used in this subcontract. The quality control samples were supplied by U.S. EPA and appear in Table 4 along with the values measured by RTI.

Table 4. Results of Quality Assurance Sample Analyses.

	RTI Mean (ug/sample)	True (ug/sample)	RTI Std. Dev., ug	Coefficient of Variation, %	% Recovery
Sample 1 (NO_3)	2020	2000	48.8	2.4	101
Sample 2 (NO_3)	296	300	6.9	2.3	99
Sample 1 (SO_4)	3911	4000	99.6	2.6	98
Sample 2 (SO_4)	482	450	12.5	2.6	107

Health Data

The study was initiated in Cleveland, Ohio, and the following is a list of location of test site, inclusive date, and number of subjects participating.

1. Central Terminal Warehouse (Cleveland) 7/18/77-11/3/77 N=109
2. Harvard Yard (Cleveland) 11/15/77-1/12/78 N=87
3. St. Alexis Hospital (Cleveland) 3/9/78-4/18/78 N=107
4. St. Lawrence Church (Cleveland) 5/23/78-6/13/78 N=57
5. Cascade School (Elyria) }
6. Prospect School (Elyria) } 7/1/78-9/31/78 N=320
7. Newburg Heights (Cleveland) 6/1/79-6/30/79 N=113

Upon arriving at the site, each volunteer signed up for a time and a day convenient for the testing procedure. Each subject was also given an envelope containing a letter describing the purpose of the research, an informed consent sheet, and a questionnaire to be filled out. All of these items appear in Appendix 1.

Within approximately one week the volunteer returned to complete the tests. Initially the volunteer sat down with one of the assistants while the questionnaire was checked for completeness or to clear up any uncertainty or confusion associated with filling out the questionnaire. When all of the questionnaire questions were answered the subject had his blood pressure taken three times, had height and weight taken and three tubes of blood were drawn from one anticubital vein. One tube was in a blue top vacutainer (trace element free) with sodium heparin as anticoagulant for the trace elements lead, mercury, arsenic, and cadmium, a second tube was a green top vacutainer with sodium heparin as anticoagulant for carboxyhemoglobin and methemoglobin and a plain vacutainer tube for the serum hormones epinephrine, norepinephrine, renin, and cortisol. At this time about 400-600 milligrams of hair was cut from the scalp for trace elements lead, mercury, arsenic and cadmium. For standardization the clump of hair was cut as close to the scalp as possible. From the scalp end, 3 cm of length was measured, cut and retained, the rest being discarded. To eliminate cutting large clumps of hair this procedure was repeated two or three times.

The trace metal analysis for the first 2 years of the study was subcontracted to Arthur Flynn of Cleveland

Metropolitan Hospital. This included the 350 volunteers from Cleveland. Assorted problems placed this subcontract in jeopardy and in July of 1978 it was cancelled by the principal investigator. This presented some serious research design problems as well as technical problems. Consequently the analysis of all of the trace elements was taken over by the research team. The equipment used was a Perkin-Elmer 460 Atomic Absorption Spectrophotometer with a graphite furnace and mercury hydride system. For detailed procedures see Methods and Materials.

As a result of this complete change of protocol and due to the very delicate nature of atomic absorption spectroscopy we attempted to obtain new human hair and blood samples so that they all could be analyzed in a standard fashion. In the summer of 1979 the research team initiated work in Newburgh Heights, Ohio, for 113 new volunteers and returned to Elyria for 120 old volunteers. The new volunteers participated in all of the tests, the old volunteers from Elyria had their hair cut and one tube of blood removed from an anticubital vein for trace elements. Although this sample size was smaller than the total population tested they did serve to standardize atomic absorption methods and enable us to compare hair and blood trace elements between test and control populations using standard methods.

Due to the short period of time remaining for the completion of the research contract all the hair samples were sent to

Stewart Laboratories, Knoxville, Tenn., for analysis. Of the 100 or so hair samples collected at each of the research sites only 45-50 were sent for trace element analysis. There were several reasons for this, 1) the time required to analyze more samples, and 2) the weight of some of the samples was below Stewart Laboratories specifications. Therefore, we matched the 45-50 samples according to age and to sex to assure homogeneity. This also provided us with good quality control and internal consistency of the data.

The next step in the protocol was pulmonary function testing (PFT). The hardware used in this test is described in Methods and Materials. The subject first had the test described, second had the test demonstrated and third had to effectively produce a maximal inspiration and maximal expiration or forced vital capacity maneuver. At this point the subject was asked to attach to the mouthpiece and breath normally. When the subject appeared relaxed and comfortable a trial maneuver was attempted. If the trial maneuver was determined to be good by direct observation on the x-y recorder, the subject came off of the mouthpiece, and if not, several trial tests were made until the subject could perform the forced expiratory maneuvers satisfactorily. The subject then reconnected to the mouthpiece for three reproducible forced vital capacity maneuvers. To check for reproducibility, the x-y recorder was invaluable. If three successive FVC maneuvers were achieved the test was over; or if three were

were not achieved the tests were continued until there was three. When it was apparent that the subject could no longer perform the test it was terminated. At least two reproducible FVC maneuvers were required before the data were included for analysis. The maximum number of FVC maneuvers for any subject was seven. The last part of PFT was a repeat of the above test except the subject breathed a helium-oxygen (80%-20%) mixture (see Methods and Materials). The volumes and capacities were recorded directly from the microprocessor and averaged. The values for $\dot{V}_{max75}$, $\dot{V}_{max50}$, $\Delta\dot{V}_{max50}$, $\Delta\dot{V}_{max75}$, and $\dot{V}_{isoV}$ were all calculated by the author. A minimum of two flow values at each 75% and 50% of the FVC were averaged for each subject. The x-y recorder was carefully calibrated by determining a variety of flow rates from a rotometer into a 120 liter Tissot spirometer (Warren E. Collins). There were converted to liter/sec for a particular rotometer reading. Flow rates from 1 through 6 liter/sec were directed into the dry rolling seal spirometer for x-y recorder verification. All flow rates were within 2% of the rotometer readings.

The third station was the electrocardiogram. Here the subject has the two arm leads attached at the midpoint and slightly below the clavicle and the two leg leads placed at the lateral border of the rectus abdominal muscles or on the first false rib. These lead placements were used to record the standard limb leads, the augmented vector leads, and V_5. To prepare for electrode placement the skin was first rubbed with an alcohol moistened gauze pad until a light erythema developed. The skin was then rubbed very gently with 6-0 sand paper to remove superficial epidermis. This preparation provides excellent recordings during rest and during work on the bicycle ergometer. While seated on the bicycle ergometer the subject's resting, 7 lead electrocardiogram was recorded on a Hewlett Packard Model 1500 B electrocardiograph. The electrocardiograph signal was fed into a Tektronix 561A oscilloscope so that the complexes could be observed during the entire test and also into a Hewlett Packard 78905A cardiotachometer to continuously monitor heart rate. Following the resting phase the subject was instructed to begin pedalling the Monarch cycle ergometer (Sweden) at 20 Kilometer/hour. While the heart rate and complex configurations were continuously monitored on the oscilloscope, the tension on the ergometer fly wheel was increased so that in general a heart rate of 110-120 b/min was reached for those patients over 45 and 130-140 b/min for those patients under 45 and then another ECG strip was recorded. There were exceptions where healthy, fit individuals over 45 were allowed to reach 140 b/min while others under 45 were terminated when the heart rate was less than 140 b/min. The total time of the ride was usually between 3 to 5 minutes. Following the ride a strip designated "immediate post exercise" was taken, and then another strip

TYPING GUIDE SHEET

at 3 minutes post exercise, all consisting of the previously mentioned 7 leads.

At the termination of the ride the EKG recording were separated into segments for study by lead and condition. Each section was carefully studied for uniformity for baseline and a series of the most uniform beats was chosen to represent that particular lead during rest, exercise, immediate post-exercise on three minutes post-exercise. No less than three complete complexes were selected for a given lead; large complexes due to slow heart rates made it difficult in some cases to fit more than three beats under the rest categories. Heart rate was calculated using lead V_5 upon the suggestion of a consulting cardiac specialist. Most heart rates in the four categories were determined on calculation of ten uniform beats. These strips were then taped to a standard form (Appendix 2) which also included the participating subject's name, identification number, location, medication, age, sex, resting and workload heart rate, workload, duration of bicycle ride and date of ride. Each EKG calibration signal and comments pertaining to the subject's EKG or his ride were clipped and mounted on the sheet as well.

Each lead was then coded using a modified version of the Minnesota Code (27). The code check list is also shown in Appendix 2. Each ECG was coded by two different coders working independently and any major coding errors or discrepancies between coded items were re-examined and a final decision made. In general these occurrences were minimal and major problems only occurred when the isoelectric line or baseline was not stable.

Medication was carefully recorded and coded. Any medication taken regularly by the subject was classified using a current Physician's Desk Reference and subsequently coded. Our particular medication code was devised as follows:

17.0 no medication
17.1 cardiac stimulants/antiarrhythmic drugs/anticoagulants
17.2 vasodilators
17.3 adrenergic blockers
17.4 diuretics
17.5 CNS drugs (tranquilizers, anticonvulsants)
17.6 anti-inflammatory drugs/analgesics
17.7 muscle relaxants/bronchdilators
17.8 contraceptive/sex hormones
17.9 other endocrine drugs

Finally the subject was asked to complete the hypertension-behavioral profile questionnaire. This questionnaire consists of three parts, 1) recent life events (28), 2) temperament (29), 3) coping ability (30). These various parts were derived from other work but were compiled in one form for our specific use. The complete questionnaire appears in Appendix 3.

Statistical Procedure

Questionnaire -

The questionnaire responses were individually tallied according to age and sex and the relative risk ratio was calculated between each of the study areas (31). The test of chi square (x^2) was then used to determine significance. Additionally, the questions were divided into syndromes by male and female as follows:

1. Cough phlem syndrome (CPS)
   - Grade 3 = a positive response for questionnaire questions 11, 12 a and 13, 14 a
   - Grade 2 = a positive response for questionnaire questions 11, 12 a or 13, 14 a
   - Grade 1 = a positive response for questions 11, 12 b, 1, 2, or 3 c, 1 or 2 or 13, 14 b, 12 or 3 c, 1 or 2
2. Shortness of breath (SOB)
   - Grade 3 = a positive response for questionnaire question #20
   - Grade 2 = a positive response for questionnaire question #19
   - Grade 1 = a positive response for questionnaire question #18
   - Grade 0 = negative response for question 18, 19, 20
3. Shortness of breath with wheezing
   - Grade 5 = a positive response to question 16 c (almost every day)

Grade 4 = a positive response to question 16 c - (many 13 or more)

Grade 3 = a positive response to question 16 c - (several 4-10)

Grade 2 = a positive response to question 16 c - (few 1-3)

Grade 1 = a positive response to question 16 c - (none)

Grade 0 = negative response to question 16

4. Wheeze Syndrome (WH)

Grade 3 = a positive response to question 15 c

Grade 2 = a positive response to question 15 b

Grade 1 = a positive response to question 15 a

Grade 0 = negative response to question 15

5. Airway Obstructive Disease (AOD)

Grade 3 = a positive response to either question 27 a, and 26 and 25

Grade 2 = CPS 2+, or WH 2+, or positive response to question 24, or SOB 2+

Grade 1 = a positive response to question 17 or 22 (2, 3, 4, or 5) or 23 (3 or 4) or 27 (a, b, c, d, e, f, or g)

Grade 0 = negative to all of the above

6. Chronic Obstructive Pulmonary Disease (COPD)

Grade 3 = a positive response to either question 27 a and 26

Grade 2 = CPS 2+ or WH 2+

Grade 1 = any grade 1 response - same as above

Grade 0 = negative response to all of the above

In the computation of relative risks we have attempted to control sex as a factor. We weighted the risk for each sex by the proportion of that sex in the total sample. The chi-square test of a significant departure from unity of the relative risk ratio is independent of the method used in computing relative risks. Where appropriate the significance probability for a given chi-square value is listed.

Pulmonary Function Testing -

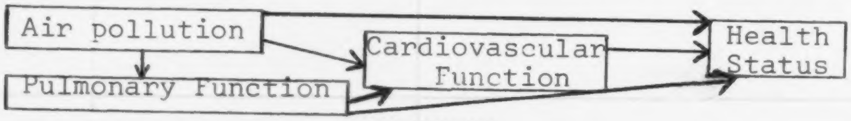
For analyzing the pulmonary function data a stepwise regression procedure was chosen. For each pulmonary function parameter we used as potential independent or predictor variables: Age, Ht, and Wt with dummy variables indicating Location, Smoking History and Socioeconomic Status. In order to avoid confounding results because of major differences between males and females with respect to pulmonary functions and the wide range of ages, we separated the subjects into six subgroups. They are (1) male age 18-35, (2) female age 18-35, (3) male age 36-50, (4) female age 36-50, (5) male age 51-75, and (6) female age 51-75.

A stepwise linear regression was chosen over a multiple regression because the stepwise procedure does not allow variables which are explaining little variation in the data to delete the explaining power of the major variables. We used a significance level of .3 so that all the major variables could be studied. Variables labeled NS for a particular pulmonary function parameter are ones which could not enter the equation at the .3 level. Variables which do enter the equation have their nonstandardized coefficients listed with the associated significance probability. The significance probability indicates how significant a given variable is once the data has been corrected for the other variables entered. The data of course remains uncorrected for variables labeled NS.

Electrocardiogram -

The ECG data were analyzed using an SPSS chi square package with significance calculated on adjusted chi square values. For each of the ECG codes analyzed a chi square test was performed between Cleveland and Elyria subjects by sex. The rationale for using chi square was that the ECG's were coded for severity and do not represent a continuous function. Therefore, it was of interest to examine if there was a significant difference in the frequency of specific ECG code, between the two populations.

Pearson correlation coefficients were used to compare pulmonary functions with ECG codes. Also discriminate analysis was used to analyze the relationship between pulmonary criterion variables and ECG predictor variables in order to test a causal theory:



Section 6

Results and Discussion

Aerometrics

The aerometric data shown in Figures 9 through 11 are for the year beginning November 1977 and ending September 1978. The values were all derived from the CHAMP program with the University of Akron only receiving the validated data. Figures 12 through 16 show the aerometric data from March 1979 to the middle of November 1979. During this time the aerometric stations were completely supported by the University of Akron and the data in these figures represent our work.

The large amount of missing data at the beginning of the sampling period (Nov. 1977) was due to the fact that it took us some time to set up and learn how to run the stations. Consequently, there were a lot of days when the stations were not running. Also all of the stations were not initiated at the same time.

The differences between the two cities as a function of comparing four stations (1412 and 1413 Cleveland) and (1414 and 1415 Elyria) show that for the year 1977-78 there are no clear differences except perhaps for NO_2. For the year 1979 the stations were controlled much better because of improved calibration and maintenance techniques and management within the group. Therefore, the number of days per month that the station ran or where the data were verified was much higher. During this year the values for SO_2 were again not very different between the two cities (1412 and 1413 Cleveland) and (1415 Elyria). Station 1414 was shut down because those data appeared to approximate the data from 1415 and it was just a duplication on our part. The data for NO_2 as before show some differences between the two cities. TSP, the respirable, and the nonrespirable particles begin to show some clear differences between the two cities. The respirable particulate fraction was made at 3.5 microns, which is a function of pore size in the Anderson sample. As seen in Figures 15 and 16 there are some large differences between the two cities. The significant differences between cities in Table 5 are for comparison between station 1412-1414 and 1413-1415, while in Table 6 both Cleveland stations are compared to 1415.

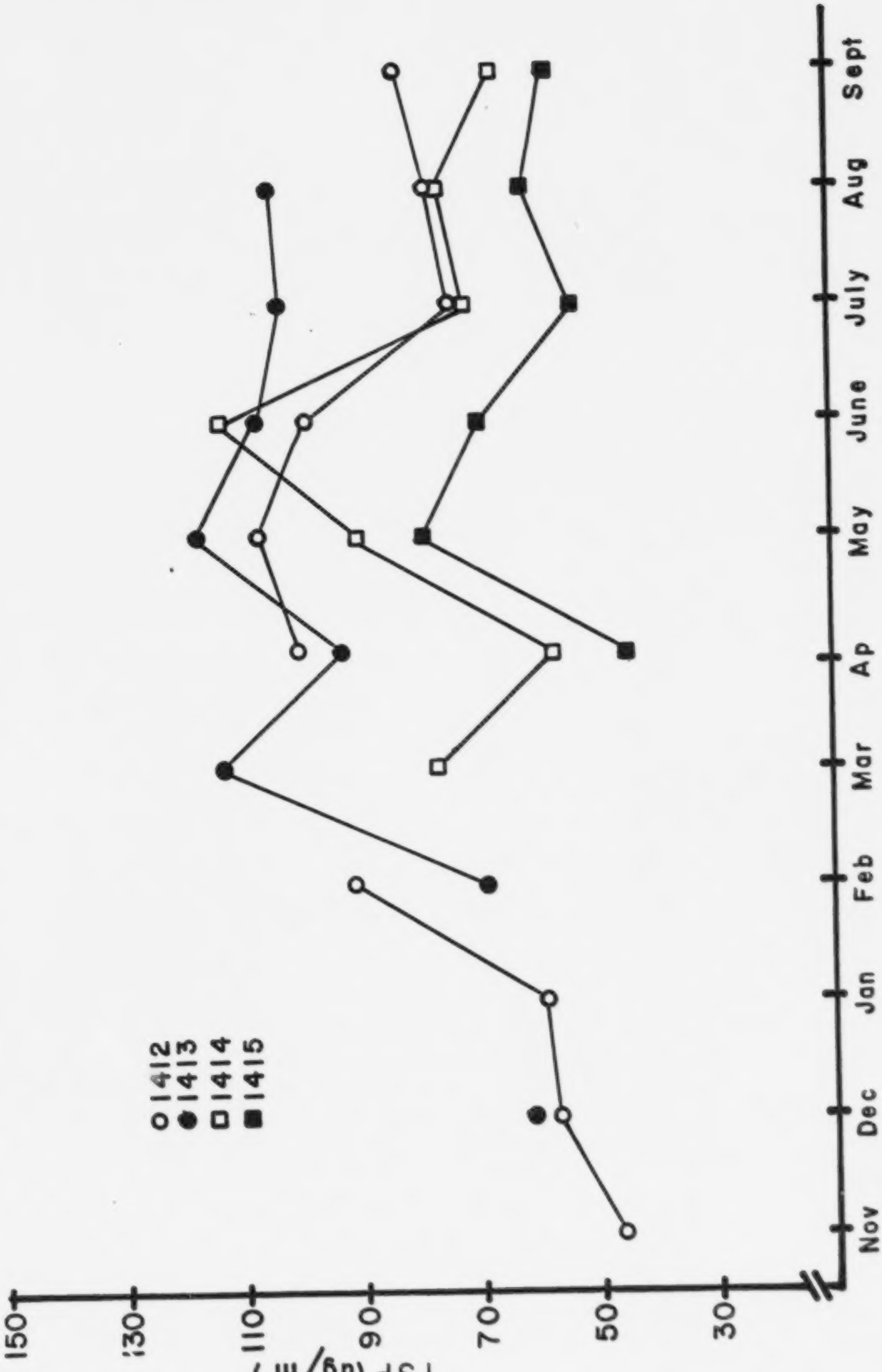


Figure 9. Monthly mean values for total suspended particles (TSP)(1977-78).

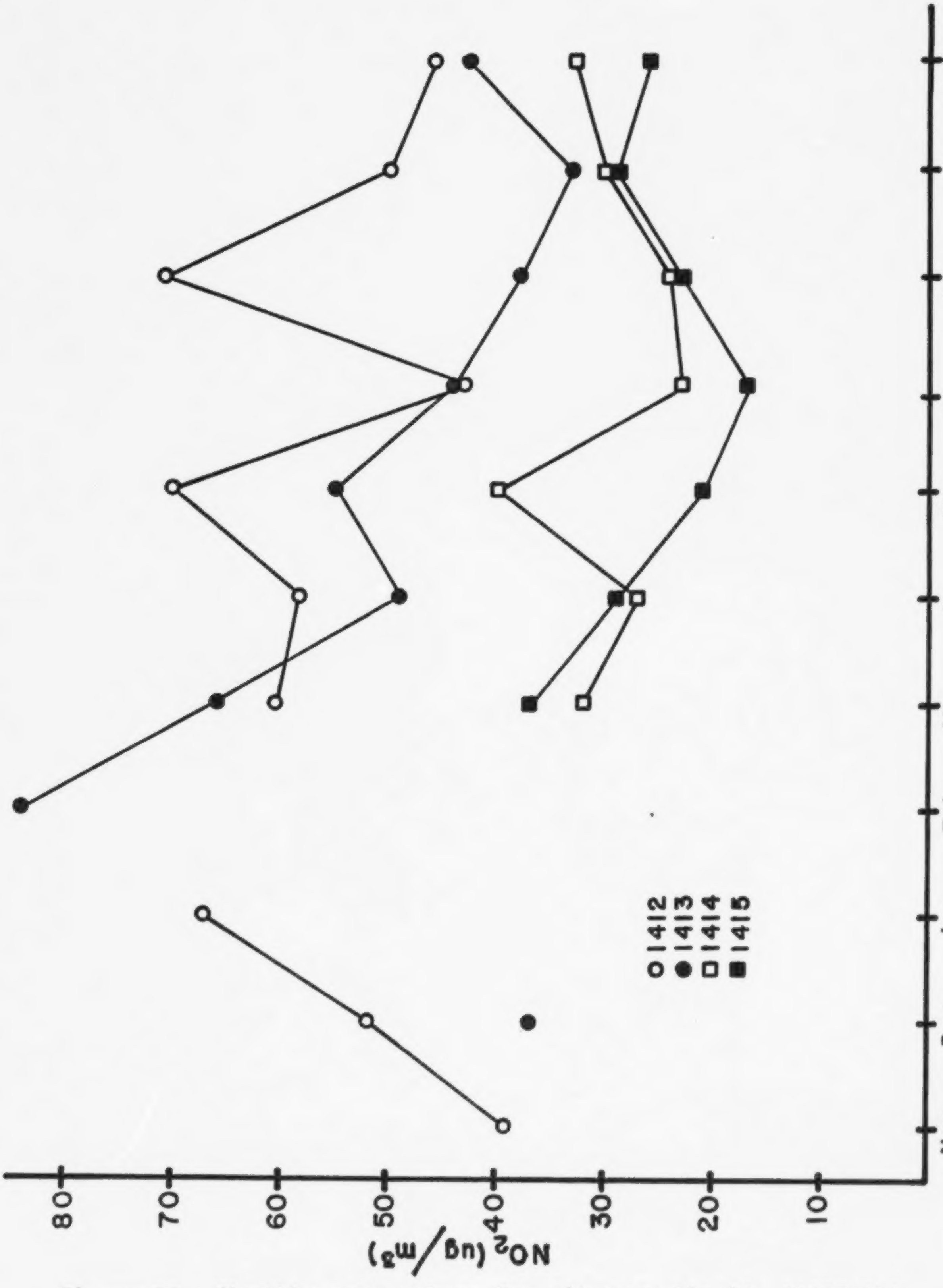


Figure 10. Monthly mean values for nitrogen dioxide (1977-78).

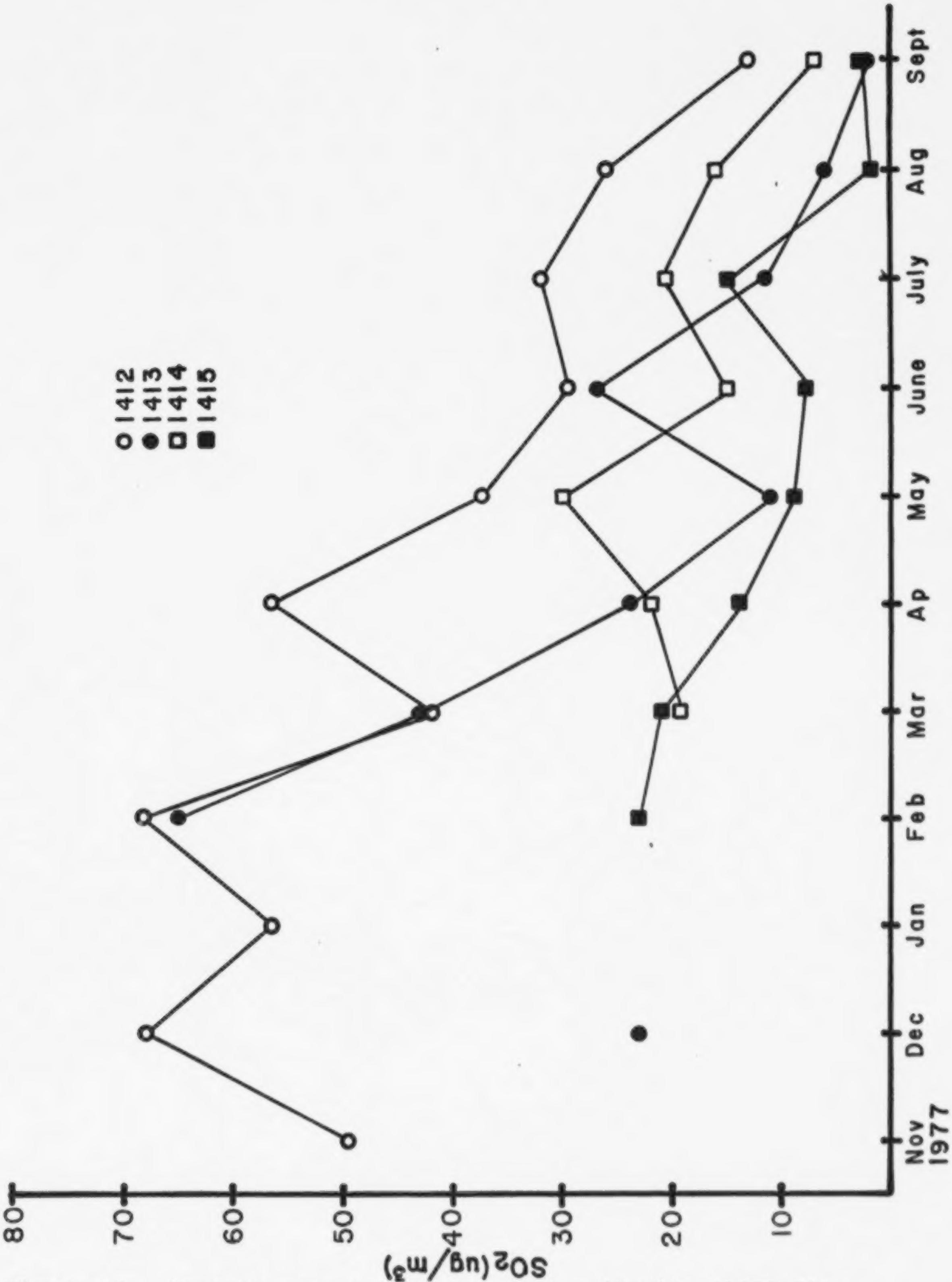


Figure 11. Monthly mean values for sulfur dioxide (1977-78).

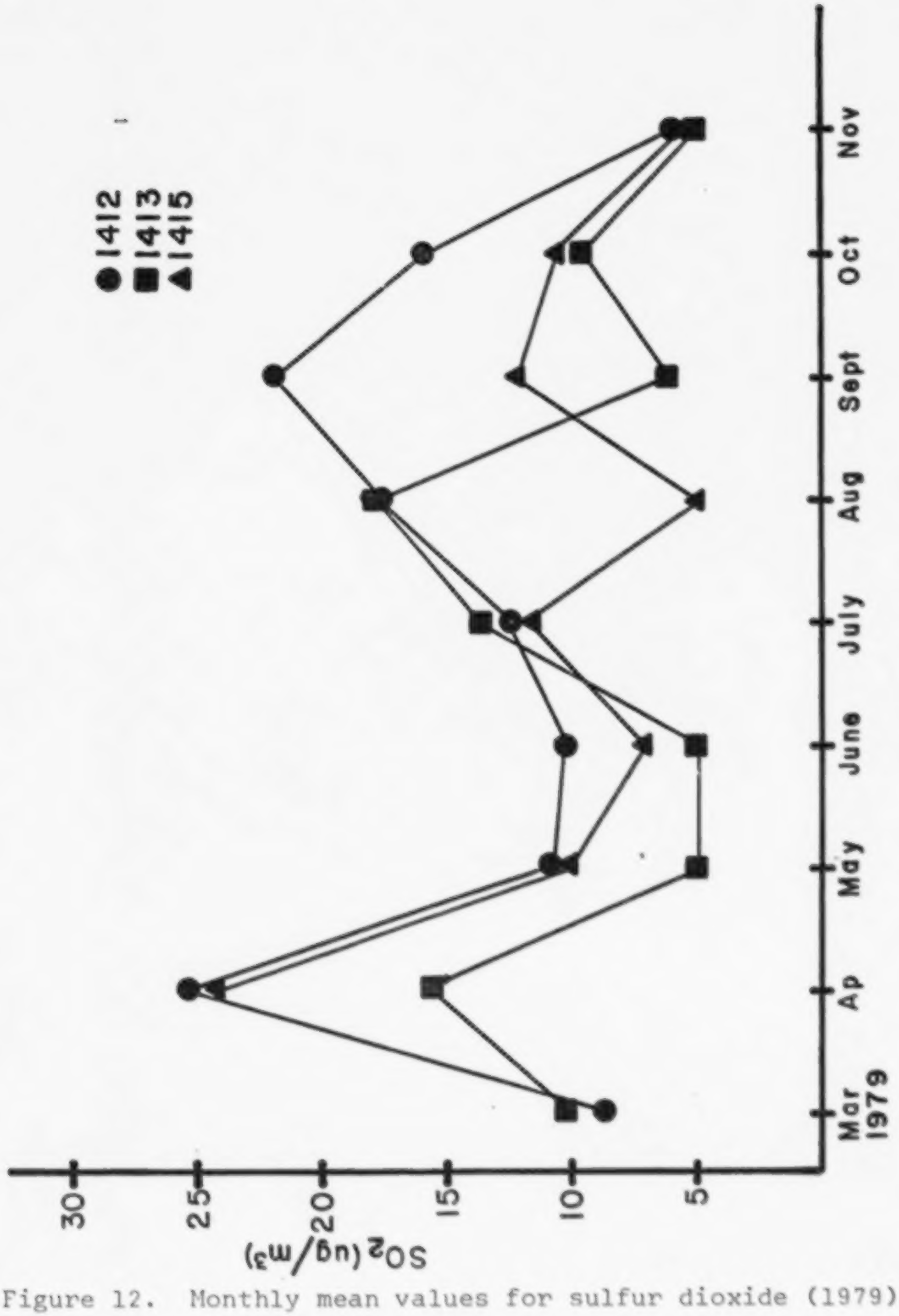


Figure 12. Monthly mean values for sulfur dioxide (1979).

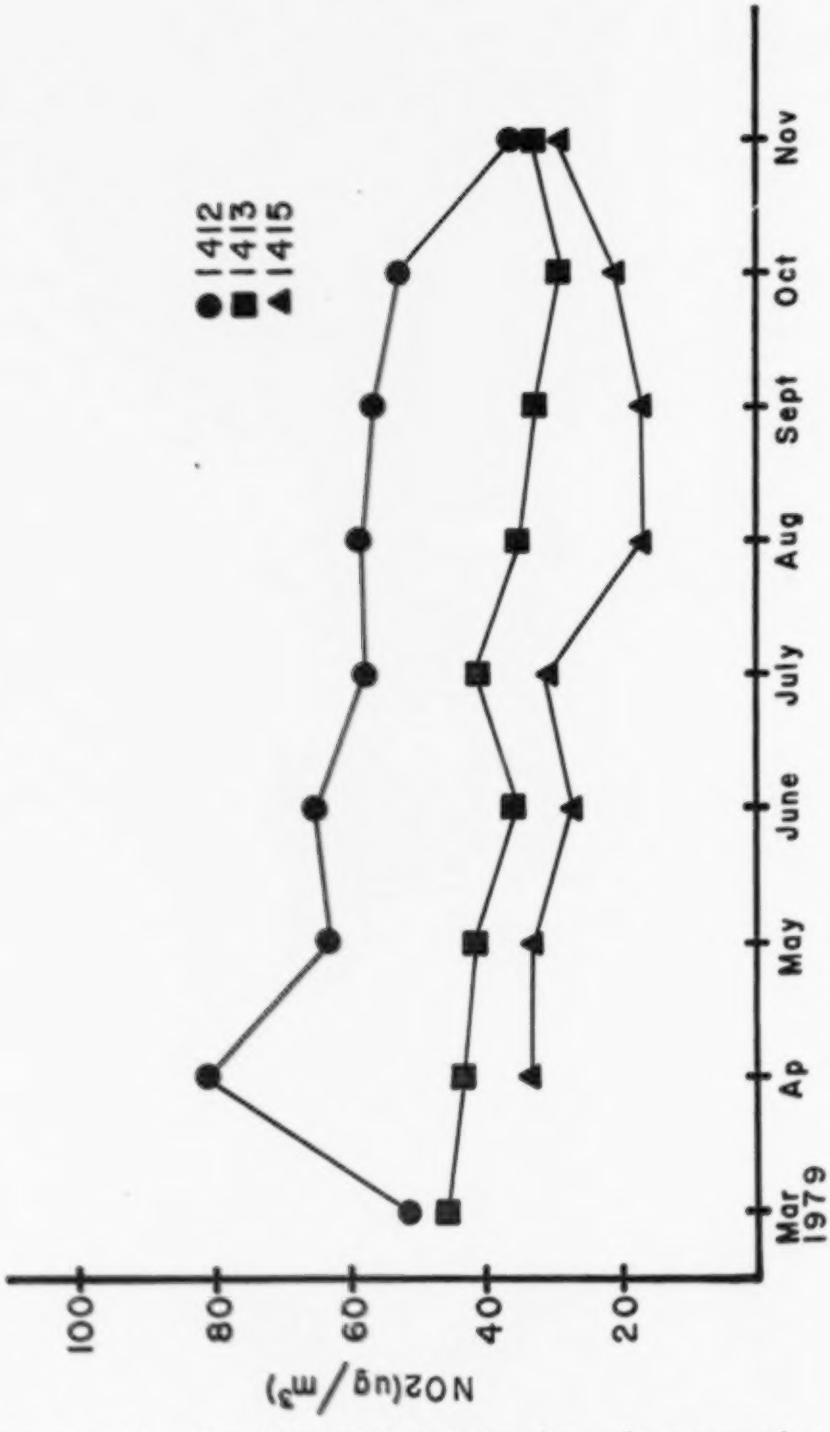


Figure 13. Monthly mean values for nitrogen dioxide (1979).

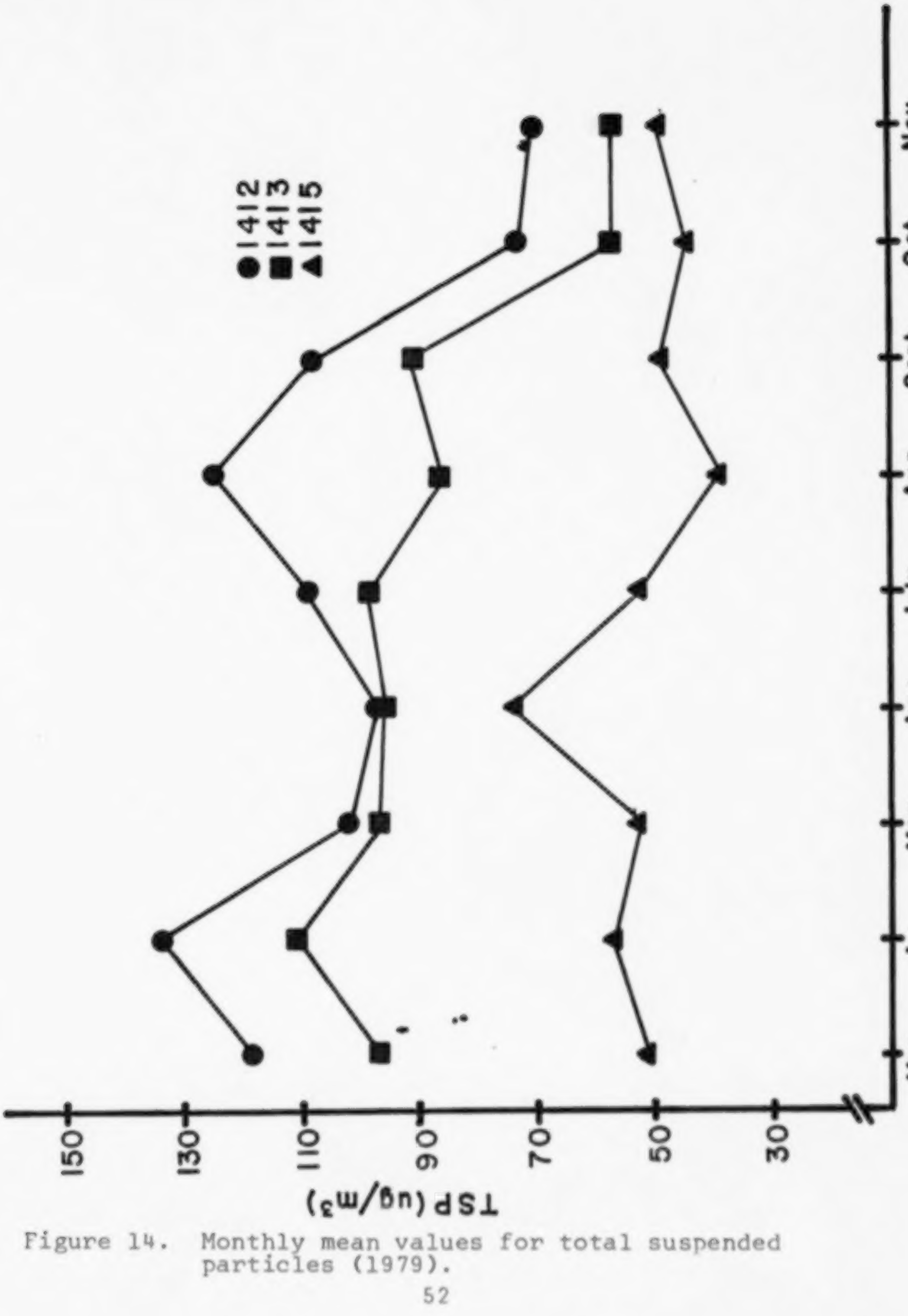


Figure 14. Monthly mean values for total suspended particles (1979).

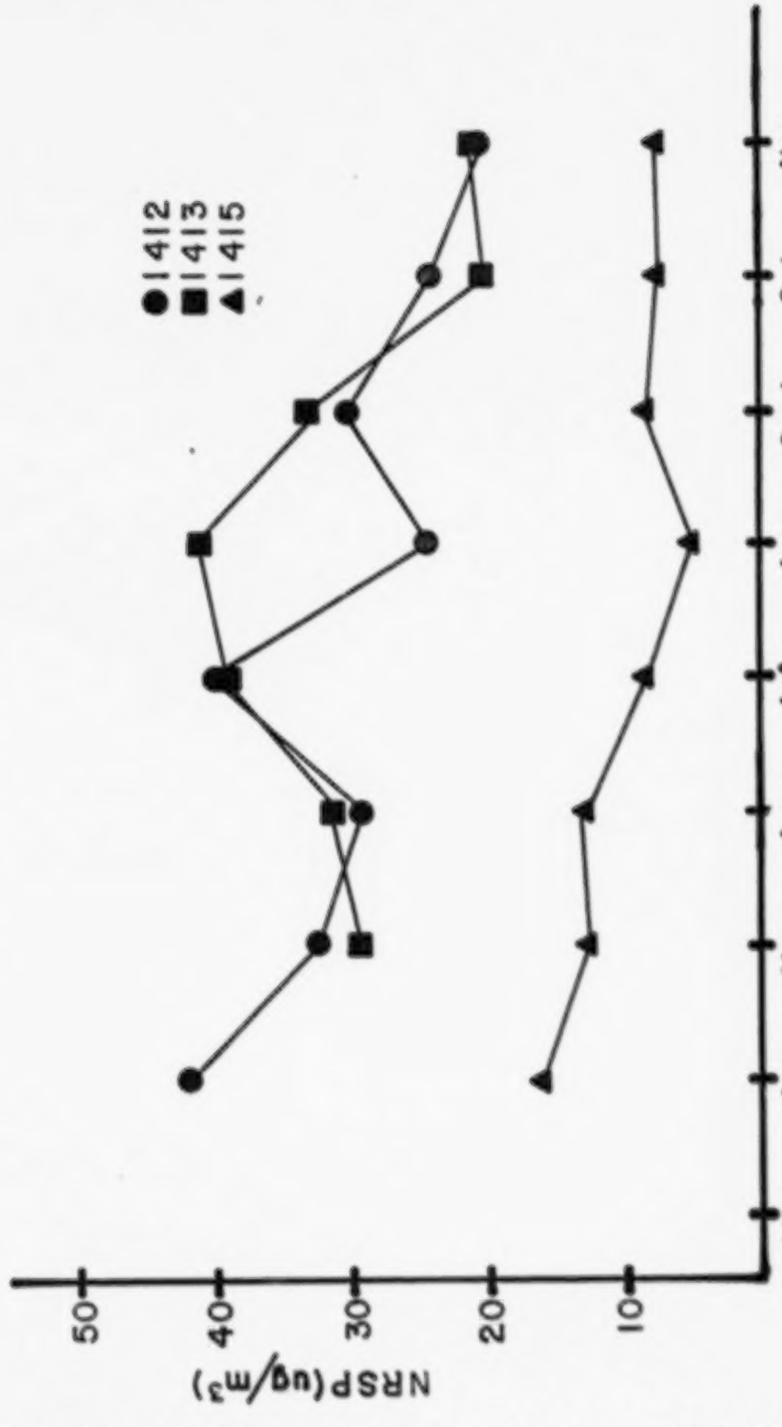


Figure 15. Monthly mean values for non-respirable suspended particles (1979).

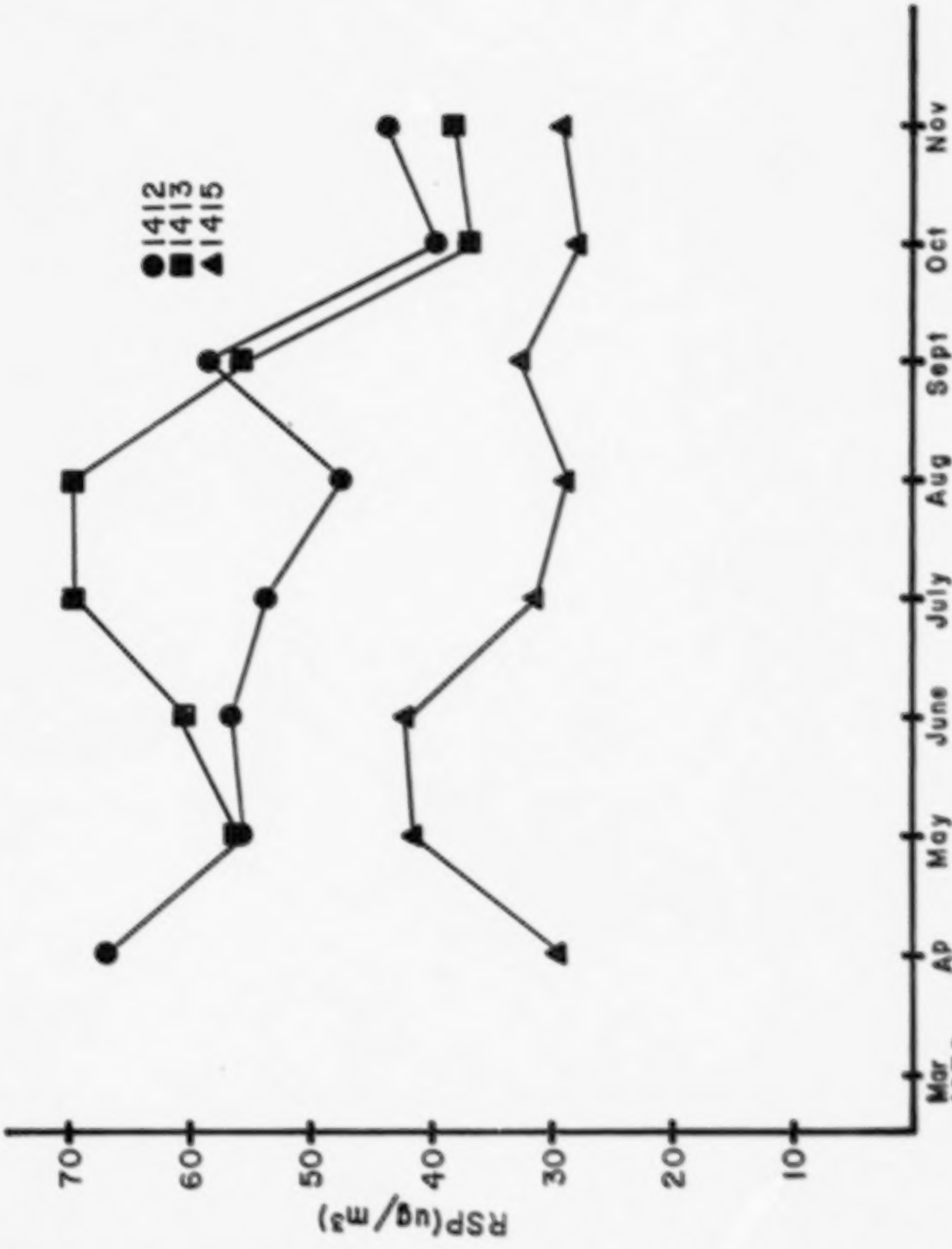


Figure 16. Monthly mean values for respirable suspended particles (1979).

Table 5. Mean aerometric data from November-September 1977-78 in Cleveland-Elyria, OH ($\bar{x} \pm SE$). Stations 1414 and 1415 are from March-September 1978.

Station	TSP	SO_4	NO_3	SO_2	NO_2
Cleveland					
1412	79.1±3.7	13.5±0.6	5.8±0.3*	45.5±3.1*	56.8±2.5*
1413	96.3±4.3*	15.6±0.9	6.1±0.3*	25.9±3.0*	52.3±2.7*
Elyria					
1414	76.3±3.5	16.7±1.1	4.5±0.3	19.8±1.8	29.0±1.0
1415	60.5±1.9	15.5±0.8	5.0±0.3	11.4±1.4	27.9±1.3

(*$p < .01$)

Table 6. Mean aerometric data from February-November, 1979 in Cleveland-Elyria, OH ($\bar{x} \pm SE$).

Station	TSP	NRSP	RSP	SO_4	NO_3	SO_2	NO_2
Cleveland							
1412	101.3±5.0*	29.9±1.9*	51.6±2.5*	17.9±1.2	6.2±0.4	14.3±1.4	57.7±2.5*
1413	86.3±4.1*	29.9±1.3*	53.4±3.2*	15.7±1.1	5.5±0.8	9.2±1.1	37.5±1.4*
Elyria							
1415	51.2±2.2	9.9+1.4	33.1±1.9	14.6±0.9	4.6±0.2	11.3±1.4	27.0±1.7

(*$p < .01$)

From the Tables it appears that the most consistent differences occur for TSP, the respirable and nonrespirable fractions and NO_2. The SO_2 values are low in Cleveland when one considers the vastness of the industrial complex in question, and also the values are very similar to the values for Elyria.

The aerometric station at 1412 had companion stations which were operated by the Cleveland Division of Air Pollution Control. These stations like others in the national surveillance system run every 6th day. We matched same day data between these two systems and over a 20 month period there were about 30 days where both were running. Table 7 shows these data.

Table 7. Same day data for station 1412 reported from Cleveland Air Pollution Control System (Clev) and University of Akron study group (AK) ($\bar{x} \pm SE$).

TSP		SO_2		NO_2	
Clev	AK	Clev	AK	Clev	AK
97.4 ± 5.9	85.2 ± 6.9	54.4 ± 4.7**	30.5 ± 3.6	72.2 ± 6.4*	56.2 ± 5.0

** = $p < .01$

* = $p < .05$

It is clear from this Table that there are large differences between the two surveillance systems for SO_2 and NO_2 in spite of the fact that both systems use the same types of collection instruments and chemical analysis. We have no explanation for these differences. It does seem that our data (AK) are rather low for SO_2. However, a similar comparison was made in Akron, OH, where one of our stations was compared to a station operated by the Akron Air Pollution Control Board. These data were presented in another EPA report and both sets compared favorably.

It is very difficult to resolve these differences between the two systems and we have no single explanation. One point of interest is that Station 1413 also had very low values for SO_2 and in fact they were very similar to station 1412.

Health Data

Population Characteristics -

The basic breakdown characteristics of the two cities can be compared from the questionnaire responses in Tables 8 and 9. In general the sample sizes between the two cities for a particular age group are quite similar. There are, however, some socioeconomic differences as measured by years of education. Table 10 gives a breakdown of the population by age groups and sex. The number of blacks participating in the study was 2% males, 5% females in Elyria, 5% males, 9% females in Cleveland. The number participating in PFT and percentages of the total population are also shown in Table 10. It is interesting to notice that 10 or more years of residence in a particular city (Question 8) includes a large percentage of the study population and as such meets an important criterion of the study.

Table 8 - Questionnaire Response - Adults from Cleveland, Ohio

*For complete question see Appendix 1.

Years of age:	Males 18-35 N=32	Males 36-50 N=11	Males 51-75 N=49	Females 18-35 N=29	Females 36-50 N=35	Females 51-75 N=143
4. Ethnic group						
1. White	29(90.6)	11(100)	45(91.8)	21(72.4)	33(94.3)	130(90.9)
2. Mex-Am.			1(2.0)			0
3. Black	3(9.4)		2(4.1)	8(27.6)	1(2.9)	10(7.0)
4. Indian			0			0
5. Oriental			0			0
6. Other			1(2.0)			2(1.4)
5. Marital status						
1. Married	9(28.1)	8(72.7)	39(79.6)	17(58.6)	27(77.1)	71(49.7)
2. Separated	0	1(9.1)	2(4.1)		1(2.9)	1(.7)
3. Never Married	21(65.6)	0	2	9(31.0)	2(5.7)	12(8.4)
4. Widowed	0	0	2		2(5.7)	48(33.6)
5. Divorced	2(6.3)	2(18.2)	4(8.2)	3(10.3)	3(8.6)	10(7.0)
6. Education						
1. under 12 years	3(9.4)	4(36.4)	28(57.1)	8(27.6)	18(51.4)	99(69.2)
2. 12 years	10(31.3)	6(54.5)	16(32.7)	19(65.5)	13(37.1)	33(23.1)
3. over 12 years	19(59.4)	1(9.1)	5(10.2)	2(6.9)	4(11.4)	11(7.7)
8. Yrs. at present city						
1. 1-5 yrs.	2(6.3)	0		2(6.9)	1(2.9)	3(2.1)
2. 5-10 yrs.	2(6.3)	2(18.2)		4(13.8)	2(5.7)	4(2.8)
3. 10 or more	28(87.5)	9(81.8)	49(100)	23(79.3)	32(91.4)	135(94.4)
10. Anticipate moving						
1. Yes	9(28.1)	2(18.2)	3(6.1)	10(34.5)	2(5.7)	6(4.2)
2. No	22(68.8)	8(72.7)	44(89.8)	17(58.6)	32(91.4)	134(94.4)
11. Cough in morning						
1. Yes	8(25.0)	5(54.4)	15(30.6)	5(17.2)	8(22.9)	28(19.6)
2. No	24(75.0)	5(45.4)	33(67.3)	24(82.8)	27(77.1)	113(79.0)
12. Cough other than in morning						
1. Yes	14(43.8)	6(54.4)	16(32.7)	6(20.7)	10(28.6)	32(22.4)

Years of age:	Males 18-35 N=32	Males 36-50 N=11	Males 51-75 N=49	Females 18-35 N=29	Females 36-50 N=35	Females 51-75 N=143
12. (continued)						
2. No	18(56.3)	4(45.5)	33(67.3)	23(79.3)	25(71.4)	111(77.6)
A. on most days for at least 3 months						
1. Yes	8(25.0)	5(45.5)	14(28.6)	5(17.2)	8(22.9)	17(11.9)
2. No	6(18.8)	1(9.1)	3(6.1)	2(6.9)	2(5.7)	12(8.4)
B. yrs. coughing						
1. <2 yrs.	6(18.8)	0	3(6.1)	3(10.3)	3(8.6)	11(7.7)
2. 2-5 yrs.	5(15.6)	6(54.5)	5(10.2)	1(3.4)	2(5.7)	7(4.9)
3. >5 yrs.	2(6.3)	0	8(16.3)	3(10.3)	5(14.3)	14(9.8)
C. cough more or less now than 2 yrs. ago						
1. More	4(12.5)	2(18.2)	8(16.3)	3(10.3)	3(8.6)	13(9.1)
2. Less	4(12.5)	1(9.1)	3(6.1)	0	3(8.6)	2(1.4)
3. No change	6(18.8)	3(27.3)	6(12.2)	4(13.8)	4(11.4)	16(11.2)
D. seen Doc. about cough in last 2 yrs.						
1. Yes	5(15.6)	1(9.1)	8(16.3)	3(10.3)	2(5.7)	17(11.9)
2. No	9(28.1)	5(45.5)	9(18.4)	4(13.8)	8(22.9)	14(9.8)
13. Phlem in morning						
1. Yes	12(37.5)	5(45.5)	19(38.8)	7(24.1)	6(17.1)	36(25.2)
2. No	20(62.5)	6(54.5)	30(61.2)	22(75.9)	29(82.9)	105(73.4)
14. Phlem other times						
1. Yes	13(40.6)	5(45.5)	18(36.7)	3(10.3)	7(20)	33(23.1)
2. No	19(59.4)	6(54.5)	31(63.3)	25(86.2)	28(80)	109(76.2)
A. on most days for at least 3 months						
1. Yes	9(28.1)	5(45.5)	16(32.7)	6(20.7)	6(17.1)	25(17.5)
2. No	4(12.5)	1(9.1)	8(16.3)	0	2(5.7)	12(8.4)
B. yrs. phlem						
1. <2 yrs.	3(9.4)	2(18.2)	4(8.2)	4(13.8)	1(2.9)	14(9.8)
2. 2-5 yrs.	6(18.8)	2(18.2)	7(14.3)	1(3.4)	2(5.7)	10(7.0)
3. >5 yrs.	4(12.5)	2(18.2)	12(24.5)	1(3.4)	5(14.3)	13(9.1)

	Years of age:	Males 18-35 N=32	Males 36-50 N=11	Males 51-75 N=49	Females 18-35 N=29	Females 36-50 N=35	Females 51-75 N=143
C.	phlem more or less now than 2 years ago						
	1. More	5(15.6)	3(27.3)	5(10.2)	2(6.9)	1(2.9)	14(9.8)
	2. Less	2(6.3)	0	5(10.2)	0	2(5.7)	5(3.5)
	3. No change	5(15.6)	3(27.3)	14(28.6)	3(10.3)	5(14.3)	19(13.3)
D.	Seen Doc. about this in last 2 yrs.						
	1. Yes	3(9.4)	1(9.1)	9(18.4)	1(3.4)	2(5.7)	20(14)
	2. No	9(28.1)	5(45.5)	14(28.6)	5(17.2)	7(20)	18(12.6)
15.	Wheeze						
	1. Yes	10(31.3)	7(63.6)	14(28.6)	9(31.0)	8(22.9)	41(28.7)
	2. No	22(68.8)	4(36.4)	35(71.4)	20(69.0)	26(74.3)	102(71.3)
A.	during colds						
	1. Yes	7(21.9)	7(63.6)	11(22.4)	8(27.6)	6(17.1)	29(20.3)
	2. No	3(9.4)	0	2(4.1)	1(3.4)	2(5.7)	10(7.0)
B.	wheeze when do not have a cold						
	1. Yes	8(25.0)	4(36.4)	7(14.3)	6(20.7)	3(8.6)	21(14.7)
	2. No	2(6.3)	3(27.3)	6(12.2)	3(10.3)	5(14.3)	19(13.3)
C.	wheeze on most days						
	1. Yes	2(6.3)	3(27.3)	5(10.2)	3(10.3)	3(8.6)	7(4.9)
	2. No	7(21.9)	4(36.4)	9(18.4)	6(20.7)	4(14.3)	29(20.3)
D.	during past yr. wheezing improved or worsened						
	1. Improved	3(9.4)	2(18.2)	1(2.0)	1(3.4)	2(5.7)	6(4.2)
	2. Worsened	3(9.4)	1(9.1)	0	1(3.4)	0	5(3.5)
	3. Same	4(12.5)	4(36.4)	13(26.5)	7(24.1)	6(17.1)	27(18.9)
E.	age first started wheezing						
	1-20 yrs.	5(15.6)		1(2.0)	6 (20.7)	1(2.9)	4(2.8)
	21-40 "	4(12.5)	5(45.4)	2(4.1)	3(10.3)	3(8.6)	5
	41-60 "		1(9.1)	8(16.3)		2(5.7)	13(9.1)

Years of age:	Males 18-35 N=32	Males 36-50 N=11	Males 51-75 N=49	Females 18-35 N=29	Females 36-50 N=35	Females 51-75 N=143
61-75 yrs.			1(2.0)			10(7.0)
16. Short of breath while wheezing						
1. Yes	3(9.4)	4(36.4)	12(24.5)	3(10.3)	6(17.1)	24(16.8)
2. No	28(97.5)	7(63.6)	37(75.5)	26(89.7)	29(82.9)	117(81.8)
A. with colds						
1. Yes	2(6.3)	4(36.4)	7(14.3)	3(10.3)	3(8.6)	12(8.4)
2. No	1(3.1)	0	5(10.2)	0	1(2.9)	11(7.7)
B. without colds						
1. Yes	1(3.1)	3(27.3)	10(20.4)	1(3.4)	3(8.6)	13(9.1)
2. No	2(6.3)	1(9.1)	2(4.1)	2(6.9)	2(5.7)	8(5.6)
C. during past yr. no. of attacks						
1. None	0	0	0	0	0	0
2. 1-3	3(9.4)	1(9.1)	4(8.2)	2(6.9)	3(8.6)	9(6.3)
3. 4-10		1	3(6.1)	1(3.4)	2(5.7)	8(5.6)
4. 13 or more		2(18.2)	3(6.1)	0	0	2(1.4)
5. everyday		0	2(4.1)	0	0	3(2.1)
D. age of first attack						
1-20 yrs.	1(3.1)		1(2.0)	3(10.3)	1(2.9)	5(3.5)
21-40 "	2(6.3)	2(18.2)			4(11.4)	1(0.7)
41-60 "		2(18.2)	9(18.4)			3(2.1)
61-75			1(2.0)			6(4.2)
E. age of last attack						
1-20 yrs.	1(3.1)			1(6.9)		
21-40 "	2(6.2)	2(18.2)		2	3(8.6)	
41-60 "		2(18.2)	6(12.2)		1(2.9)	8(5.6)
61-75 "			3(6.1)			13(9.1)
17. More short of breath than most people of same age						
1. Yes	3(9.4)	4(36.4)	8(16.3)	5(17.2)	6(17.1)	16(11.2)
2. No	29(90.6)	7(63.6)	39(79.6)	24(82.8)	29(82.9)	117(81.8)

Years of age:	Males 18-35 N=32	Males 36-50 N=11	Males 51-75 N=49	Females 18-35 N=29	Females 36-50 N=35	Females 51-75 N=143
18. Short of breath while hurrying on level ground or walk up slight hill						
1. Yes	4(12.5)	7(63.6)	20(40.8)	9(31.0)	21(60)	73(51.0)
2. No	28(87.5)	4(36.4)	29(59.2)	20(69.0)	14(40)	66(46.2)
19. Short of breath walking with age peers on level ground						
1. Yes	1(3.1)	3(27.3)	6(12.2)	4(13.8)	7(20)	28(19.6)
2. No	31(96.9)	8(72.7)	41(83.7)	24(82.8)	27(77.1)	112(78.3)
20. Stop for breath while walking at own pace on level ground						
1. Yes	1(3.1)	3(27.3)	6(12.2)	2(6.9)	2(5.7)	22(15.4)
2. No	31(96.9)	8(72.7)	42(85.7)	27(93.1)	32(91.4)	115(80.4)
21. Respiratory trouble before age 16						
1. Yes	3(9.4)		2(4.1)	4(13.8)		10(7.0)
2. No	27(84.4)	11(1)	47(95.9)	25(86.2)	34(97.1)	129(90.2)
22. During past 3 yrs. trouble with bronchitis, chest colds, pneumonia						
1. some	14(43.8)	3(27.3)	20(40.8)	15(51.7)	20(57.1)	56(39.2)
2.	7(21.9)	3	6(12.2)	4(13.8)	1(2.9)	16(11.2)
3.	4(12.5)	2(18.2)	2(4.1)	4(13.8)	7(20)	9(6.3)
4.	2(6.3)	1(9.1)	1(2.0)	0	0	2(1.4)
5. great deal			5(10.2)	1(3.4)	1(2.9)	3(2.1)

Years of age:	Males 18-35 N=32	Males 36-50 N=11	Males 51-75 N=49	Females 18-35 N=29	Females 36-50 N=35	Females 51-75 N=143
23. During past 3 yrs. how often disabled due to chest colds, bronchitis, pneumonia						
1. Never	22(68.8)	5(45.5)	37(75.5)	14(48.3)	21(60.0)	96(67.1)
2. 1 illness	3(9.4)	4(36.4)	6(12.2)	10(34.5)	7(20)	26(18.2)
3. 2-5 illnesses	7(21.9)	2(18.2)	4(8.2)	3(10.3)	4(11.4)	15(10.5)
4. 6 or more illnesses	0	0	2(4.1)	0	1(2.9)	2(1.4)
24. Think you have asthma, bronchial trouble, emphysema						
1. Yes	2(6.3)	4(36.4)	12(24.5)	6(20.7)	6(17.1)	32(22.4)
2. No	29(90.6)	7(63.6)	37(75.5)	22(75.9)	29(82.9)	110(76.9)
25. Seen Doc. for asthma						
1. Yes		1(9.1)	6(12.2)	3(10.3)	1(2.9)	7(4.9)
2. No	32(100)	10(90.9)	43(87.8)	24(82.8)	34(97.1)	134(93.7)
A. during past yr. symptoms						
1. Improved	1(3.1)		3(6.1)	1(3.4)	0	3(2.1)
2. Worsened	0		1(2.0)	1(3.4)	0	4(2.8)
3. Same	0	1(9.1)	2(4.1)	0	1(2.9)	0
B. during past yr. no breathing problem for 2 weeks						
1. Yes	0	1(9.1)	2(4.1)	2(6.9)	1(2.9)	2(1.4)
2. No	1(3.1)		4(8.2)	1(3.4)	0	3(2.1)
C. time treatment brings relief						
1. W/in min.	0	1(1.1)	2(4.1)	1(3.4)	0	2(1.4)
2. W/in hrs.	1(3.1)		1(2.0)	1(3.4)	0	0
3. W/in days	0		0	0	0	2(1.4)
4. No relief	0		0	0	0	0
5. No treat.	0		3(6.1)	1(3.4)	1(2.9)	1(0.7)

Years of age:	Males 18-35 N=32	Males 36-50 N=11	Males 51-75 N=49	Females 18-35 N=29	Females 36-50 N=35	Females 51-75 N=143
26. Seen Doc. for chronic bronchitis						
1. Yes	1(3.1)		5(10.2)	4(13.8)	2(5.7)	18(12.6)
2. No	31(96.9)	11(100)	44(89.8)	24(82.8)	32(91.4)	125(87.4)
A. during past yr. symptoms						
1. Improved			0	2(6.9)	1(2.9)	5(3.5)
2. Worsened			1(2.0)	0	0	5(3.5)
3. Same			4(8.2)	2(6.9)	1	7(4.9)
B. taken medication treatment						
1. Yes			4(8.2)	4(13.8)	1(2.9)	13(9.1)
2. No			1(2.0)	0	1(2.9)	4(2.8)
27.						
A. Emphysema						
1. Yes, still have it			3(6.1)			1(.7)
2. Yes, but no longer have it			1(2.0)			0
3. No	32(100)	11(100)	44(89.8)	27(93.1)	34(97.1)	142(99.3)
B. Bronchieostasis						
1. Yes, st.	0		3(6.1)	0	0	3(2.1)
2. Yes, but	2(6.3)		2(4.1)	2(6.9)	3(8.6)	3(2.1)
3. No	30(93.8)	11(100)	43(87.8)	25(86.2)	30(85.7)	135(94.4)
(same as above answers)						
C. Sinus trouble						
1. Yes, st.	9(28.1)	4(36.4)	14(28.6)	6(20.7)	10(28.6)	44(30.8)
2. Yes, but	2(6.3)	0	3(6.1)	0	1(2.9)	4(2.8)
3. No	20(62.5)	7(63.6)	32(65.3)	22(75.9)	23(65.7)	90(62.9)
D. Pneumonia or Bronchopneumo						
1. Yes, st.	0	0	0	0	0	1(.7)
2. Yes, but	3(9.4)	1(9.1)	6(12.2)	2(6.9)	5(14.3)	14(9.8)
3. No	29(90.6)	10(90.9)	43(87.8)	27(93.1)	29(82.9)	127(88.8)

Years of age:	Males 18-35 N=32	Males 36-50 N=11	Males 51-75 N=49	Females 18-35 N=29	Females 36-50 N=35	Females 51-75 N=143
E. TB						
1. Yes, st.			0	0		0
2. Yes, but			1(2.0)	0		4(2.8)
3. No	32(100)	11(100)	48(98.0)	28(96.6)	34(97.1)	139(97.2)
F. Valley fever						
1. Yes, st.						
2. Yes, but						
3. No	32(100)	10(90.9)	49(100)	29(100)	34(97.1)	141(98.6)
G. Histo.						
1. Yes, st.						
2. Yes, but						
3. No	32(100)	11(100)	46(93.9)	28(96.6)	31(88.6)	139(97.2)
H. Other respiratory disease						
1. Yes	1(3.1)		6(12.2)	2(6.9)	1(2.9)	13(9.1)
2. No	31(96.9)	11(100)	39(79.6)	24(82.8)	30(85.7)	101(70.6)
28. Yrs. at present occupation						
1. 1-5 yrs.	19(59.4)	2(18.2)	4(8.2)	19(65.5)	19(28.6)	19(13.3)
2. 5-10 yrs.	7(21.9)	3(27.3)	0	5(17.2)	7(20	13(9.1)
3. 10 or more	2(6.3)	5(45.4)	30(61.2)	2(6.9)	8(22.9)	44(30.8)
29. In past, dusty job, gas, chem. fumes, smoke,						
1. Yes	22(68.8)	7(27.3)	27(55.1)	7(24.1)	9(25.7)	36(25.2)
2. No	10(31.3)	4(36.4)	22(44.9)	22(75.9)	25(71.4)	98(68.5)
A. yrs. employed there						
1. 1-5 yrs.	18(56.3)	2(18.2)	5(10.2)	6(20.7)	6(17.1)	13(9.1)
2. 5-10 yrs.	3(9.4)	2(18.2)	1(2.0)	1(3.4)	2(5.7)	7(4.9)
3. 10 or more	0	3(27.3)	20(40.8)	0	1(2.9)	14(9.8)
B. exposure						
1. Mild	5(15.6)	0	5(10.2)	4(13.8)	6(17.1)	16(11.2)
2. Moderate	13(40.6)	4(36.4)	14(28.6)	3(10.3)	2(5.7)	15(10.5)
3. Severe	4(12.5)	3(27.3)	6(12.2)	0	1(2.9)	4(2.8)

Years of age:	Males 18-35 N=32	Males 36-50 N=11	Males 51-75 N=49	Females 18-35 N=29	Females 36-50 N=35	Females 51-75 N=143
C. no. of cos. employed at in past 10 yrs.						
1-3 cos.	11(34.4)	6(54.5)	23(46.9)	6(20.7)	5(14.3)	21(14.7)
4-6 "	8(25.0)		0	1(3.4)		
7-10 "	1(3.1)		1(2.0)			
30. Now, smoke cigarettes						
1. Yes	19(59.4)	5(54.4)	15(30.6)	13(44.8	14(40)	24(16.8)
2. No	13(40.6)	5(45.4)	34(69.4)	16(55.2)	21(60)	119(83.2)
A. inhale						
1. Yes	18(56.3)	6(54.5)	15(30.6)	10(34.5)	10(28.6)	14(9.8)
2. No	0			3(10.3)	4(11.4)	10(7.0)
B. filters						
1. Yes	18(56.3)	1(9.1)	10(20.4)	13(44.8)	13(87.1)	19(13.3)
2. No	0	5(45.4)	3(6.1)		1(2.9)	3(2.1)
C. no. cigs. per day at present						
1-20 cigs.	17(53.1)	4(36.3)	9(18.4)	10(34.5)	11(31.4)	21(14.7)
21-40 "	2(6.2)		6(12.2)	3(10.3)	3(8.6)	2(1.4)
41-60 "		2(18.1)				1(.7)
61-75 "						
D. age began						
1-20 yrs.	16(50.0)	6(54.5)	10(20.4)	12(41.4)	5(14.3)	11(7.7)
21-40 "	3(9.4)		5(10.2)	1	8(22.9)	12(8.4)
41-60 "					1(2.9)	
61-75 "						
E. no. cigs. per day when began						
1-20 cigs.	17(53.1)		11(22.4)	13(44.8)	10(28.6)	17(11.9)
21-40 "	1(3.1)	5(45.4)	3(6.1)		3(8.6)	2(1.4)
41-60 "		1(9.1)				1(1.4)
61-75 "						

Years of age:	Males 18-35 N=32	Males 36-50 N=11	Males 51-75 N=49	Females 18-35 N=29	Females 36-50 N=35	Females 51-75 N=143
F. smoking less now than 2 yrs. ago						
1. Yes	6(18.8)	1(9.1)	6(12.2)	2(6.9)	4(11.4)	12(8.4)
2. No	13(40.6)	5(45.5)	8(16.3)	10(34.5)	10(28.6)	10(7.0)
G. If so, how many cigarettes smoke now						
1-20 cigs.	8(25.0)	2(18.2)	5(10.2)	2(6.9)	5(14.3)	11(7.7)
21-40 "			1(2.0)		1(2.9)	1(.7)
41-60 "			1(2.0)			
61-75 "						
31. If not smoking cigarettes now, did you used to						
1. Never	10(31.3)	2(18.2)	10(20.4)	9(31.0)	14(40)	89(62.2)
2. Regularly	3(9.4)	1(9.1)	19(38.8)	3(10.3)	4(11.4)	18(12.6)
3. Occasionally		2	6(12.2)	4(13.8)	3(8.6)	7(4.9)
A. no. smoked/day						
1-20 cigs.	2(6.3)	2(18.2)	18(36.7)	6(20.7)	7(20.0)	20(14.0)
21-40 "	1		4(8.2)	1(3.4)		2(1.4)
41-60 "			3(6.1)			1(.7)
61-75 "						
B. inhale						
1. Yes	3(9.4)	1(9.1)	17(34.7)	4(13.8)	5(14.3)	13(9.1)
2. No		1(9.1)	8(16.3)	2(6.9)	2(5.7)	8(5.6)
C. age began						
1-20 yrs.	3(9.4)	2(18.2)	15(30.6)	5(17.2)	6(17.1)	9(6.3)
21-40 "			3(6.1)	1(3.4)	1(2.9)	12(8.4)
41-60 "						3(2.1)
61-75 "						
D. age when stopped						
1-20 yrs.	1(3.1)	1	1(2.0)	2(6.9)	1(2.9)	
21-40 "	2(6.3)	1	6(12.2)	3(10.3)	4(11.4)	10(7.0)
41-60 "			17(34.7)		1(2.9)	10(7.0)
61-75 "						4(2.8)

Years of age:	Males 18-35 N=32	Males 36-50 N=11	Males 51-75 N=49	Females 18-35 N=29	Females 36-50 N=35	Females 51-75 N=143
E. stopped due to cough, wheezing, shortness of breath						
1. Yes	1(3.1)		9(18.4)	2(6.9)	1(2.9)	7(4.9)
2. No	2(6.3)	2(18.2)	16(32.7)	5(17.2)	5(14.3)	16(11.2)
32. Now, pipes or cigars						
1. Yes	6(18.8)		6(12.2)			2(1.4)
2. No	26(81.3)	11(100)	41(83.7)	26(89.7)	33(94.3)	123(86.0)
A. no./day						
1-20	4(12.5)		6(12.2)			
21-40						
41-60						
61-75						
B. age began						
1-20 yrs.	5(15.6)		2(4.1)			
21-40 "			2(4.1)			
41-60 "			2(4.1)			
61-75 "						
C. inhale, usually						
1. Yes	3(9.4)		1(2.0)			
2. No	3(9.4)		5(10.2)			
33. Used to smoke pipes or cigars						
1. Never	17(53.1)	4(36.4)	18(36.7)	26(89.7)	30(85.7)	109(76.2)
2. Regularly	0	1(9.1)	(16.3)			0
3. Occasionally	7(21.9)	6(54.5)	15(30.6)			1(.7)
A. no./day						
1-20	6(18.8)	7(63.6)	20(40.8)			1(.7)
21-40			1(2.0)			
41-60						
61-75						

Years of age:	Males 18-35 N=32	Males 36-50 N=11	Males 51-75 N=49	Females 18-35 N=29	Females 36-50 N=35	Females 51-75 N=143
B. age began						
1-20 yrs.	4(12.5)	3(27.3)	8(16.3)			1(0.7)
21-40 "	3(9.4)	4(36.4)	11(22.4)			
41-60 "			3(6.1)			
61-75 "						
C. age stopped						
1-20 yrs.	2	4(36.4)	4(8.2)			
21-40 "	4	2(18.2)	6(12.2)			
41-60 "		1(9.1)	11(22.4)			1(.7)
61-75 "						
D. usually inhale						
1. Yes	5(15.6)	4(36.4)	9(18.4)			0
2. No	2(6.3)	3(27.3)	12(24.5)			1(.7)
34. Pain or discomfort in chest due to excitement or exertion, relieved by rest						
1. Yes	12(37.5)	8(72.7)	15(30.6)	5(17.2)	12(34.3)	63(44.1)
2. No	20(62.5)	3(27.3)	34(69.4)	24(82.8)	22(62.9)	79(55.2)
35. Doc. said you have Angina (Pectoris)						
1. Yes	1(3.1)		5(30.6)			14(9.8)
2. No	31(96.9)	11(100)	44(89.8)	28(96.6)	35(100)	129(90.2)
36. Have to stop, catch breath going up flight of stairs						
1. Yes		5(45.4)	10(20.4)	4(13.8)	8(22.9)	39(27.3)
2. No	32(100)	6(54.5)	39(79.6)	24(82.8)	27(77.1)	103(72.0)
37. Hospitalized for heart attack						
1. Yes		1(9.1)	8(16.3)		1(2.9)	4(6.3)
2. No	32(100)	10(90.9)	41(83.7)	28(96.6)	32(91.4)	134(93.7)

Years of age:	Males 18-35 N=32	Males 36-50 N=11	Males 51-75 N=49	Females 18-35 N=29	Females 36-50 N=35	Females 51-75 N=143
38. Taking medication						
1. Yes	3(9.4)	3(27.3)	29(59.2)	4(13.8)	7(20)	77(53.8)
2. No	29(90.6)	8(72.7)	20(40.8)	25(86.2)	27(77.1)	65(45.5)
39. Name of medicine						

Table 9 - Questionnaire Response - Adults from Elyria, Ohio
*For complete question reading see Appendix 1.

Years of age:	Males 18-35 N=24	Males 36-50 N=37	Males 51-75 N=53	Females 18-35 N=28	Females 36-50 N=47	Females 51-75 N=104
4. Ethnic group						
1. White	23(95.8)	37(100)	52(98.1)	28(100)	44(93.6)	95(91.3)
2. Mex-Am.						
3. Black	1(4.2)		1(1.9)		2(4.3)	7(6.7)
4. Indian						
5. Oriental						
6. Other					1(2.1)	2(1.9)
5. Marital status						
1. Married	16(66.7)	36(97.3)	52(98.1)	22(78.6)	43(91.5)	59(56.7)
2. Separated			1(1.9)			3(2.9)
3. Never married	4(16.7)	1(2.7)		5(17.9)	1(2.1)	4(3.8)
4. Widowed						30(28.8)
5. Divorced	4(16.7)			1(3.6)	3(6.4)	8(7.7)
6. Education						
1. Under 12 years	1(4.2)	5(13.5)	11(20.8)	4(14.3)	3(6.4)	27(26.0)
2. 12 years	9(37.5)	11(29.7)	28(52.8)	8(28.6)	24(51.1)	53(51.0)
3. Over 12 years	14(58.3)	21(56.8)	14(26.4)	16(57.1)	20(42.6)	24(23.1)
8. Yrs. at present city						
1. 1-5 yrs.	4(16.7)	2(5.4)	3(5.7)	9(32.1)	2(4.3)	6(5.8)
2. 5-10 yrs.	7(29.2)	5(13.5)	3(5.7)	4(14.3)	5(10.6)	7(6.7)
3. 10 or more	13(54.2)	30(81.1)	47(88.7)	15(53.6)	40(85.1)	9(86.5)
9. Yrs. at present address						
1. 1-5 yrs.	11(45.8)	12(32.4)	12(22.6)	14(50.0)	14(29.8)	26(25.0)
2. 5-10 yrs.	8(33.3)	9(24.3)	6(11.3)	11(39.3)	7(14.9)	16(15.4)
3. 10 or more	5(20.8)	16(43.2)	34(64.2)	3(10.7)	26(55.3)	60(57.7)

Years of age:	Males 18-35 N=24	Males 36-50 N=37	Males 51-75 N=53	Females 18-35 N=28	Females 36-50 N=47	Females 51-75 N=104
10. Anticipate moving						
1. Yes	8(33.3)	2(5.4)	4(7.5)	7(25.0)	3(6.4)	8(7.7)
2. No	16(66.7)	35(94.6)	49(92.5)	21(75.0)	44(93.6)	94(90.4)
11. Cough in morning						
1. Yes	3(12.5)	7(18.9)	17(32.1)	4(14.3)	6(12.8)	28(26.9)
2. No	1(87.5)	30(81.1)	36(67.9)	24(85.7)	41(87.2)	76(73.1)
12. Cough other than in morning						
1. Yes	3(12.5)	11(29.7)	16(30.2)	3(10.7)	8(17.0)	27(26.0)
2. No	21(87.5)	26(70.3)	37(69.8)	25(89.3)	39(83.0)	77(74.0)
A. on most days for at least 3 mths.						
1. Yes	4(16.7)	10(27.0)	18(34.0)	3(10.7)	9(19.1)	24(23.1)
2. No	0	1(2.7)	1(1.9)	1(3.6)	1(2.1)	4(3.8)
B. years coughing						
1. < 2 yrs.	0	2(5.4)	5(9.4)	3(10.7)	2(4.3)	7(6.7)
2. 2-5 yrs.	2(8.3)	3(8.1)	5(9.4)	0	3(6.4)	8(7.7)
3. > 5 yrs.	2(8.3)	6(16.2)	9(17.0)	1(3.6)	5(10.6)	12(11.5)
C. cough more or less now than 2 years ago						
1. More	0	4(10.8)	10(18.9)	3(10.7)		7(6.7)
2. Less	0	2(5.4)	2(3.8)	0		4(3.8)
3. No change	4(16.7)	5(13.5)	7(13.2)	1(3.6)	9(19.1)	18(17.3)
D. seen doc. about cough in last 2 years						
1. Yes	0	2(5.4)	12(22.6)	1(3.6)	4(8.5)	18(17.3)
2. No	4(16.7)	9(24.3)	7(13.2)	3(10.7)	5(10.6)	11(10.6)

Years of age:	Males 18-35 N=24	Males 36-50 N=37	Males 51-75 N=53	Females 18-35 N=28	Females 36-50 N=47	Females 51-75 N=104
13. Phlem in morning						
1. Yes	3(12.5)	3(21.6)	17(32.1)	3(10.7)	13(27.7)	25(24.0)
2. No	21(87.5)	29(78.4)	36(67.9)	25(89.3)	33(70.2)	79(76.0)
14. Phlem other times						
1. Yes	4(16.7)	9(24.3)	19(35.8)	2(7.1)	9(19.1)	21(20.2)
2. No	20(83.3)	28(75.7)	34(64.2)	26(92.9)	38(80.9)	83(79.8)
A. on most days for at least 3 mths.						
1. Yes	4(16.7)	10(27.0)	18(34.0)	2(7.1)	19(21.3)	21(20.2)
2. No	0	0	2(3.8)	0	3(6.4)	2(1.9)
B. yrs. phlem						
1. 2 yrs.	0	0	2(3.8)	2(7.1)	1(12.1)	9(8.7)
2. 2-5 yrs.	2(8.3)	3(8.1)	4(7.5)		5(10.6)	5(4.8)
3. 5 yrs.	2(8.3)	7(18.9)	13(24.5)		6(12.8)	9(8.7)
C. phlem more or less now than 2 years ago						
1. More	0	2(5.4)	5(9.4)	2(7.1)	3(6.4)	7(6.7)
2. Less	0	1(2.7)	3(5.7)		1(2.1)	1(1.0)
3. No change	4(16.7)	7(18.9)	11(20.8)		8(17.0)	14(13.5)
D. seen doc. about this in last 2 years						
1. Yes	0	2(5.4)	8(15.1)	1(3.6)	3(6.4)	12(11.5)
2. No	4(16.7)	8(21.6)	12(22.6)	1(3.6)	8(17.0)	11(10.6)
15. Wheeze						
1. Yes	7(29.2)	12(32.4)	29(37.7)	5(17.9)	14(29.8)	26(35.0)
2. No	17(70.8)	25(67.6)	33(62.3)	23(82.1)	33(70.2)	77(74.0)
A. during colds						
1. Yes	7(29.2)	11(29.7)	19(35.8)	4(14.3)	12(25.5)	21(20.2)
2. No	0	L92.7)	1(1.9)	1(3.6)	2(4.3)	5(4.8)

Years of age:	Males 18-35 N=24	Males 36-50 N=37	Males 51-75 N=53	Females 18-35 N=28	Females 36-50 N=47	Females 51-75 N=104
15. (continued)						
B. wheeze when do not have a cold						
1. Yes	3(12.5)	9(24.3)	13(24.5)	2(7.1)	6(12.8)	16(15.4)
2. No	4(16.7)	2(5.4)	7(13.2)	3(10.7)	7(14.9)	8(7.7)
C. wheeze on most days						
1. Yes	0	7(18.9)	6(11.3)	0	1(2.1)	6(5.8)
2. No	7(29.2)	5(13.5)	14(26.4)	5(17.9)	12(25.5)	17(16.3)
D. during past yr. wheezing improved or worsened						
1. Improved	2(8.3)	0	2(3.8)	0	1(2.1)	5(4.8)
2. Worsened	0	0	4(7.5)	2(7.1)	1(2.1)	3(2.9)
3. Same	4(16.7)	12(32.4)	14(26.4)	2(7.1)	11(23.4)	18(17.3)
E. age first started wheezing						
1-20 yrs.	3*	3(8.1)	3(5.7)	1(3.6)	2(4.3)	5(4.8)
21-40 "	1(4.2)	6(16.2)	4(7.5)	4(14.3)	8(17.0)	2(1.9)
41-60 "		1(2.7)	8(15.1)		2(4.3)	12(11.5)
61-75 "						5(4.8)
16. Short of breath while wheezing						
1. Yes	2(8.3)	7(18.9)	12(22.6)	3(10.7)	10(21.3)	18(17.3)
2. No	22(96.7)	30(81.1)	40(75.5)	25(89.3)	37(78.7)	85(81.7)
A. with colds						
1. Yes	1(4.2)	5(13.5)	7(13.2)	3(10.7)	7(14.9)	15(14.4)
2. No	1(4.2)	1(2.7)	5(9.4)	0	3(6.4)	3(2.9)
B. without colds						
1. Yes	1	7(18.9)	10(18.9)	2(7.1)	8(17.0)	12(11.5)
2. No	1	0	1(1.9)	1(3.6)	2(4.3)	4(3.8)
C. during past year no. of attacks						

Years of age:	Males 18-35 N=24	Males 36-50 N=37	Males 51-75 N=53	Females 18-35 N=28	Females 36-50 N=47	Females 51-75 N=104
1. None	1(4.2)	0	2(3.8)	0	0	3(2.9)
2. 1-3	1(4.2)	1(2.7)	3(5.7)	1(3.6)	5(10.6)	5(4.8)
3. 4-10	0	2(5.4)	2(3.8)	0	3(6.4)	5(4.8)
4. 13 or more	0	0	1(1.9)	2(7.1)	1(2.1)	2(1.9)
5. Every-day	0	4(10.8)	4(7.5)	0	0	2(1.9)
D. age of first attack						
1-20 yrs.	1(4.2)	2(5.4)	2(3.8)	1(3.6)	1(2.1)	4(3.8)
21-40 "		5(13.5)	4(7.5)	2(7.1)	5(10.6)	1
41-60 "			6(11.3)		4(8.5)	6(5.8)
61-75 "						4(3.8)
E. age of last attack						
1-20 yrs.			2(3.8)			
21-40 "	1(4.2)	1(2.7)		1(3.6)	1	
41-60 "		6(16.2)	6(11.3)		9(19.1)	10(9.6)
61-75 "			4(7.5)			7(6.7)
17. More short of breath than most people of same age						
1. Yes	4(16.7)	7(18.9)	11(20.8)	4(14.3)	11(23.4)	11(10.6)
2. No	19(79.2)	29(78.4)	40(75.5)	24(85.7)	34(72.3)	87(83.7)
18. Short of breath while hurrying on level ground or walking up slight hill						
1. Yes	4(16.7)	10(27.0)	22(41.5)	5(17.9)	23(48.9)	51(49.0)
2. No	20(83.3)	27(73.0)	31(58.5)	23(82.1)	24(51.1)	53(51.0)
19. Short of breath walking with peers on level ground						
1. Yes	0	4(10.8)	12(22.6)	1(3.6)	7(14.9)	18(17.3)

Years of age:	Males 18-35 N=24	Males 36-50 N=37	Males 51-75 N=53	Females 18-35 N=28	Females 36-50 N=47	Females 51-75 N=104
2. No	24(100)	33(89.2)	49(75.5)	26(92.9)	39(83.0)	83(79.8)
20. Stop for breath while walking at own pace level ground?						
1. Yes	1(4.2)	2(5.4)	8(15.1)	1(3.6)	3(6.4)	13(12.5)
2. No	23(95.8)	35(94.6)	45(84.9)	27(96.4)	44(93.6)	88(84.6)
21. Respiratory trouble before age 16						
1. Yes	2(8.3)	3(8.1)	6(11.3)	2(7.1)	3(6.4)	13(12.5)
2. No	22(91.7)	34(91.9)	47(88.7)	26(92.9)	44(93.6)	91(87.5)
22. During past 3 yrs. trouble with bronchitis, chest colds, pneumonia						
1. some	16(66.7)	24(64.9)	28(52.8)	18(64.3)	22(46.8)	52(50.0)
2.	3(12.5)	3(8.1)	6(11.3)	3(10.7)	8(17.0)	11(10.6)
3.	1(4.2)	2(5.4)	7(13.2)	2(7.1)	5(10.6)	6(5.8)
4.	2(8.3)	1(2.7)	2(3.8)	2(7.1)	1(2.1)	2(1.9)
5. great deal				1	2(4.3)	5(4.8)
23. During past 3 yrs. how often disabled due to chest colds, bronchitis, pneumonia						
1. Never	16(66.7)	23(62.2)	36(67.9)	21(75.0)	24(51.1)	60(57.7)
2. 1 illness	4(16.7)	7(18.9)	7(13.2)	2(7.1)	8(17.0)	26(25.0)
3. 2-5 illnesses	4(16.7)	6(16.2)	5(9.4)	5(17.9)	13(27.7)	13(12.5)
4. 6 or more illnesses	0	1(2.7)	5(9.4)	0	1(2.1)	5(4.8)

Years of age:	Males 18-35 N=24	Males 36-50 N=37	Males 51-75 N=53	Females 18-35 N=38	Females 36-50 N=47	Females 51-75 N=104
24. Think you have: asthma, bronchial trouble, emphysema						
1. Yes	6(25.0)	9(24.3)	14(26.4)	4(14.3)	14(29.8)	23(22.1)
2. No	18(75.0)	28(75.7)	39(73.6)	24(85.7)	33(70.2)	79(76.0)
25. Seen Doc. for asthma						
1. Yes	1(4.2)	5(13.5)	7(13.2)	0	4(8.5)	8(7.7)
2. No	23(95.8)	32(86.5)	46(86.8)	28(100)	43(91.5)	94(90.4)
A. during past yr. symptoms						
1. Improved	0	2(5.4)	2(3.8)		2(4.3)	3(2.9)
2. Worsened	0	1(2.7)	2(3.8)		2(4.3)	0
3. Same	2(8.3)	1(2.7)	4(7.5)			7(6.7)
B. during past yr. no breathing problem for 2 weeks						
1. Yes	2(8.3)	3(8.1)	6(11.3)		4(8.5)	6(5.8)
2. No	0	2(5.4)	2(3.8)			3(2.9)
C. time treatment brings relief						
1. W/in minutes	0	1(2.7)	2(3.8)		1(2.1)	0
2. W/in hours	0	1(2.7)	1(1.9)		3(6.4)	1(1.0)
3. W/in days	0	0	2(3.8)			5(4.8)
4. No relief	0	0	0			0
5. No treatment	2(8.3)	2(5.4)	3(5.7)			4(3.8)
26. Seen Doc. for chronic bronchitis						
1. Yes	2(8.2)	4(10.8)	7(13.2)	1(3.6)	6(12.8)	12(11.5)
2. No	22(91.7)	33(89.2)	46(86.8)	27(96.4)	41(87.2)	90(86.5)

Years of age:	Males 18-35 N=24	Males 36-50 N=37	Males 51-75 N=53	Females 18-35 N=38	Females 36-50 N=47	Females 51-75 N=104
A. during past yr. symptons						
1. Improved	0	1(2.7)	1(1.9)	0	1(2.1)	7(6.7)
2. Worsened	2(8.3)	1(2.7)	4(7.5)	1(3.6)	1(2.1)	2(1.9)
3. Same	0	2(5.4)	2(3.8)	0	2(4.3)	3(2.9)
B. taken medication treatment						
1. Yes	1(4.2)	3(8.1)	5(9.4)	1(3.6)	3(6.4)	11(10.6)
2. No	1(4.2)	1(2.7)	2(3.8)	0	1(2.1)	1(1.0)
27.						
A. Emphysema						
1. Yes, still have it	0	1(2.7)	5(9.4)			3(2.9)
2. Yes, but no longer have it	0	0	1(1.9)			1(11.0)
3. No	24(100)	35(97.3)	45(84.9)	28(100)	46(97.9)	99(95.2)
B. Bronchieostasis						
1. Yes, st.	0	1(2.7)	1(1.9)			2(1.9)
2. Yes, but	3(12.5)	0	0	1(3.6)		5(4.8)
3. No	21(87.5)	36(97.3)	50(94.3)	27(96.4)	45(95.7)	94(90.4)
(same as above answers)						
C. Sinus trouble						
1. Yes, st.	10(41.7)	14(37.8)	22(41.5)	15(53.6)	28(59.6)	43(41.3)
2. Yes, but	0	5(13.5)	7(13.2)	1(3.6)	4(8.5)	10(9.6)
3. No	14(58.3)	18(48.6)	24(45.3)	12(42.9)	14(29.8)	50(48.1)
D. Pneumonia or Broncho-pneumo						
1. Yes, st.	0	0	0	0	0	1(1.0)
2. Yes, but	5(20.8)	7(18.9)	13(24.5)	3(7.1)	10(21.3)	27(26.0)
3. No	19(79.2)	30(81.1)	49(75.5)	25(78.7)	37(78.7)	76(73.1)

Years of age:	Males 18-35 N=24	Males 36-50 N=37	Males 51-75 N=53	Females 18-35 N=38	Females 36-50 N=47	Females 51-75 N=104
E. TB						
1. Yes, st.	0	0	1(1.9)		0	0
2. Yes, but	0	0	1(1.9)		1(2.1)	5(4.8)
3. No	24(100)	37(100)	50(94.3)	28(100)	46(97.9)	99(95.2)
F. Valley Fever						
1. Yes, st.	0	0	0			
2. Yes, but	0	0	0			
3. No	24(100)	37(100	52(98.1)	28(100)	46(97.9)	104(100)
G. Histo.						
1. Yes, st.	0		0			
2. Yes, but	0		1(1.9)			
3. No	24(100)	36(97.3)	51(96.2)	28(100)	46(97.9)	104(100)
H. Other Respiratory Disease						
1. Yes	1(4.2)	1(2.7)	8(15.1)	6(21.4)	6(12.8)	11(10.6)
2. No	23(95.8)	35(94.6)	35(66.0)	22(78.6)	38(80.9)	83(79.8)
28. Yrs. at present occupation						
1. 1-5 yrs.	16(66.7)	4(10.8)	2(3.8)	12(42.9)	12(25.5)	9(8.7)
2. 5-10 "	7(29.2)	5(13.5)	3(5.7)	4(14.3)	13(27.7)	5(4.8)
3. 10 or more	1(4.2)	27(73.0)	27(50.9)	7(25.0)	14(29.8)	36(34.6)
29. In past, dusty job, gas, chem. fumes, smoke						
1. Yes	15(62.5)	17(45.9)	31(58.5)	4(14.3)	9(19.1)	24(23.1)
2. No	9(37.5)	29(54.1)	22(41.5)	24(85.7)	36(76.6)	80(76.9)
A. yrs. employed there						
1. 1-5 yrs.	13(54.2)	9(24.3)	2(3.8)	2(7.1)	3(6.4)	7(6.7)
2. 5-10 "	2(8.3)	2(5.4)	2(3.8)	0	4(8.5)	4(3.8)
3. 10 or more	0	6(16.2)	26(49.1)	2(7.1)	2(4.3)	12(11.5)

Years of age:	Males 18-35 N=24	Males 36-50 N=37	Males 51-75 N=53	Females 18-35 N=28	Females 36-50 N=47	Females 51-75 N=104
B. exposure						
1. Mild	1(4.2)	0	5(9.4)	3(7.1)	3(6.4)	8(7.7)
2. Mod.	12(50.0)	13(35.1)	17(32.1)	1(3.6)	3	9(8.7)
3. Severe	2(8.3)	3(8.1)	8(15.1)	0	2(4.3)	6(5.8)
C. no. of companies employed in past 10 yrs.						
1. 1-3 cos.	8(33.3)	17(45.9)	28(52.8)	3(10.7)	8(17.0)	18(17.3)
2. 4-6 "	5(20.8)				1(2.1)	1(1.0)
3. 7-10 "	1(4.2)					
30. Now, smoke cigarettes						
1. Yes	10(41.7)	13(35.1)	14(26.4)	7(25.0)	15(31.9)	30(28.8)
2. No	14(58.3)	24(64.9)	39(73.6)	21(75.0)	32(68.1)	74(71.2)
A. inhale						
1. Yes	10(41.7)	11(29.7)	14(26.4)	7(25.0)	14(29.8)	25(24.0)
2. No	0	1(2.7)	1(1.9)	0	1(2.1)	5(4.8)
B. filters						
1. Yes	9	10(27.0)	13(24.5)	7(25.0)	12(25.5)	27(26.0)
2. No	1(4.2)	2(5.4)	1(1.9)	0	1(2.1)	2(1.9)
C. no. cigarettes/ day at present						
1-20 cigs.	4(16.7)	8(21.6)	13(24.5)	6(21.4)	9(19.1)	21(20.2)
21-40 "	5(20.8)	4(10.8)	1(1.9)		5(10.6)	9(8.7)
41-60 "	1(4.2)	1(2.7)		1(3.6)		
61-75 "						
D. age began						
1-20 yrs.	10(41.7)	10(27.0)	12(22.6)	7(25.0)	13(27.6)	18(17.3)
21-40 "		3(8.1)	2(3.8)		1(2.1)	12(11.5)
41-60 "						
61-75 "						

Years of age:	Males 18-35 N=24	Males 36-50 N=37	Males 51-75 N=53	Females 18-35 N=28	Females 36-50 N=47	Females 51-75 N=104
E. no. of cigarettes/day when began						
1-20 cigs.	7(29.2)	11(29.7)	9(17.0)	6(21.4)	14(29.8)	24(23.1)
21-40 "	2(8.3)	1(2.7)	5(9.4)	1(3.6)	1(2.1)	4(3.8)
41-60 "	1(4.2)	1(2.7)				
61-75 "						
F. smoking less now than 2 yrs. ago						
1. Yes	3(12.5)	5(13.5)	2(3.8)	3(10.7)	2(4.3)	6(23.1)
2. No	7(29.2)	8(21.6)	12(22.6)	4(14.3)	12(25.5)	24(71.2)
G. if so, how many cigarettes smoke now						
1-20 cigs.	1(4.2)	4(10.8)	1(1.9)	3(10.7)	1(2.1)	6(5.8)
21-40 "	1(4.2)	1(2.7)				
41-60 "						
61-75 "						
31. If not smoking cigarettes now, did you used to						
1. Never	5(20.8)	10(27.0)	19(18.9)	12(42.9)	17(36.2)	49(47.1)
2. Regularly	3(12.5)	9(24.3)	26(49.1)	5(17.9)	11(23.4)	12(11.5)
3. Occasionally	6(25.0)	4(10.8)	3(5.7)	3(10.7)	4(8.5)	12(11.5)
A. no. smoked/day						
1-20 cigs.	9(37.5)	9(24.3)	13(24.5)	7(25.0)	10(21.3)	19(18.3)
21-40 "		3(8.1)	12(22.6)		5(10.6)	4(3.8)
41-60 "			4(7.5)	1(3.6)	5(10.6)	
61-75 "		1(2.7)				
B. inhale						
1. Yes	8(33.3)	12(32.4)	25(47.2)	7(25.0)	12(25.5)	10(9.6)
2. No	1(4.2)	1(2.7)	4(7.5)	0	3(6.4)	13(12.5)

Years of age:	Males 18-35 N=24	Males 36-50 N=37	Males 51-75 N=53	Females 18-35 N=28	Females 36-50 N=47	Females 51-75 N=104
C. age began						
1-20 yrs.	9(37.5)	9(24.3)	24(45.3)	5(17.8)	11(23.4)	11(10.6)
21-40 "		4(10.8)	5(9.4)		4(8.5)	9(8.6)
41-60 "						3(2.9)
61-75 "						
D. age when stopped						
1-20 yrs.	5(20.8)			3(10.7)	3(6.4)	
21-40 "	3(12.5)	13(35.1)	14(26.4)	4(14.3)	5(10.6)	8(7.7)
41-60 "			13(24.5)		1(2.1)	15(14.4)
61-75 "			2(3.8)			
E. stopped due to cough, wheezing, shortness of breath						
1. Yes	1(4.2)	5(13.5)	11(20.8)	2(7.1)	2(4.3)	6(5.8)
2. No	8(33.3)	8(21.6)	17(32.1)	6(21.4)	13(27.7)	16(15.4)
32. Now, pipes or cigars						
1. Yes	4(16.7)	8(21.6)	9(17.0)			3(2.9)
2. No	19(79.2)	27(73.0)	43(81.1)	28(100)	46(97.9)	94(90.4)
A. no./day						
1-20	4(16.7)	8(21.6)	8(15.1)			1(1.0)
21-40						
41-60						1(1.0)
61-75						
B. age began						
1-20 yrs.	3(12.5)	4(10.8)	5(9.4)			1(1.0)
21-40 "		4(10.8)	3(5.7)			
41-60 "						
61-75 "						1(1.0)
C. inhale, usually						
1. Yes	3(12.5)	2(5.4)	5(9.4)		41(87.2)	1(1.0)
2. No	1(4.2)	6(16.2)	4(7.5)			1(1.0)

Years of age:	Males 18-35 N=24	Males 36-50 N=37	Males 51-75 N=53	Females 18-35 N=28	Females 36-50 N=47	Females 51-75 N=104
33. Used to smoke pipes or cigars						
1. Never	9(37.5)	19(51.4)	24(45.3)	28(100)		88(84.6)
2. Regularly	1(4.2)	3(8.1)	9(17.0)			
3. Occasionally	10(41.7)	6(16.2)	9(17.0)			
A. no./day						
1-20	9(37.5)	9(24.3)	18(40.0)			
21-40						
41-60						
61-75						
B. age began						
1-20 yrs.	7(29.2)	2(5.4)	10(18.9)			
21-40 "	3(12.5)	7(18.9)	7(13.2)			
41-60 "			1(1.9)			
61-75 "						
C. age stopped						
1-20 yrs.	6(25)		2(3.8)			
21-40 "	3(12.5)	8(21.6)	7(13.2)			
41-60 "		1(2.7)	11(20.7)			
61-75 "			3(5.7)			
D. usually inhale						
1. Yes	5(20.8)	3(8.1)	12(22.6)			
2. No	5(20.8)	7(18.9)	6(11.3)			
34. Pain or discomfort in chest due to excitement or exertion, relieved by rest						
1. Yes	7(29.2)	13(35.1)	20(37.7)	5(17.9)	17(36.2)	46(44.2)
2. No	17(70.8)	24(64.9)	33(62.3)	23(82.1)	29(61.7)	58(55.8)
35. Doc. said you have Angina (Pectoris)						
1. Yes	0	1(2.7)	6(11.3)		1(2.1)	12(11.5)

Years of age:	Males 18-35 N=24	Males 36-50 N=37	Males 51-75 N=53	Females 18-35 N=28	Females 36-50 N=47	Females 51-75 N=104
35. (continued)						
2. No	24(100)	36(97.3)	46(86.8)	28(100)	46(97.9)	92(88.5)
36. Have to stop, catch breath going up flight of stairs						
1. Yes	0	3(8.1)	7(13.2)	4(14.3)	8(17.0)	27(26.0)
2. No	2(100)	34(91.9)	46(96.3)	23(82.1)	39(83.0)	75(72.1)
37. Hospitalized for heart attack						
1. Yes	0	1(2.7)	5(9.4)		2(4.3)	8(7.7)
2. No	24(100)	36(97.3)	48(90.6)	28(100)	45(95.7)	96(92.3)
38. Taking medication						
1. Yes	2(8.3)	7(18.9)	25(47.2)	7(25.0)	19(40.4)	54(51.9)
2. No	22(91.7)	30(81.1)	28(52.8)	21(75.0)	28(59.6)	50(48.1)
39. Name of medicine						

Table 10. Age and sex distribution of residents completing the questionnaire and participating in PFT.

	Number Completing Questionnaire			
Sex-location	18-35 years	36-50 years	51-75 years	Total
Males				
Cleveland	32	11	49	92
Elyria	24	37	53	114
Females				
Cleveland	29	35	143	207
Elyria	28	47	104	179
	Number Participating in PFT and % of Total			
Males				
Cleveland	32(100%)	11(100%)	45(92%)	88(96%)
Elyria	23(96%)	27(100%)	51(96%)	111(97%)
Females				
Cleveland	29(100%)	33(94%)	127(89%)	189(91%)
Elyria	27(96%)	44(94%)	90(86%)	161(90%)

Questionnaires -

Questionnaire responses for Cleveland and Elyria separated by sex and age are shown in Tables 8 and 9. The relative risk ratios (RRR) for selected questions were calculated according to Mantel and Haenszel (31) and are shown in Table 11. In general the RRR's exceed 1.0 indicating that the risk for a particular response is higher in Cleveland. Specifically the general responses are higher in Cleveland and frequently significant for the young males and females but the risk is lower and less than 1.0 for the older males and females. Levels of probability for a given RRR are shown in parentheses.

The RRR for the syndrome are shown in Table 12. There is again a general trend for the values to be greater than 1.0 (more risk in Cleveland) with the CPS syndrome being the only one with statistically significant RRR values.

Spirometry -

In the multiple linear regression model, all of the spirometric data were regressed against the independent variables age, height, weight, location, smoking, socioeconomic status (SES 1), (SES 2), and (SES 3). The last four independent variables were dummy variables and were inserted into the program as follows: (Location) - 0 = Cleveland, 1 = Elyria; (Smoking) - 0 = never smoked, 1 = smoked cigarettes; (SES 1) - 0 = 12 or more years of education, 1 = less than 12 years; (SES 2) - 0 = less or more than 12 years of education, 1 = 12 years; (SES 3) - 0 = 12 or less years of education, 1 = more than 12 years. The results are shown in Tables 13 through 18. The levels of probability in these Tables indicate how significant a given variable is after it has been corrected for all of the others.

The males 18-35, females 18-35, and males 51-75 were the only groups to show significant location differences. The males 18-35 and females 18-35 residing in Cleveland all had reduced lung functions following regression as indicated. The probability levels for the 51-75 year old males lung functions were not as significant as the 18-35 year old males and females.

Table 11
Relative Risk Ratios (RRR) and Levels of Probability for Questionnaire Response in Cleveland and Elyria, Ohio (RRR = $\frac{\text{RR Cleveland}}{\text{RR Elyria}}$)*

	Males 18-35 N=56	Males 36-50 N=48	Males 51-75 N=102	Females 18-35 N=57	Females 36-50 N=82	Females 51-75 N=47
Cough in the morning (#11)	2.0	2.4 (P = .08)	.96	1.21	1.80	.73
Couth other than in the morning (#12)	3.5 (P = .01)	1.8 (P = .1)	1.08	1.93	1.68	.86
Phlem in the morning (#13)	3.0 (P =.04)	5.6 (P = .007)	1.21	2.25	.62	1.05
Phlem other times (#14)	2.4 (P = .05)	1.8	1.03	1.45	1.05	1.14
Wheeze (#15)	1.07	1.96 (P = .07)	.52	1.74	.77	1.14
Shortness of breath with wheeze (#16)	1.13	1.92	1.08	.97	.81	.97
Shortness of breath while hurrying on level ground (#18)	.75	2.36 (P = .03)	.98	1.74	1.23	1.04
Stop for breath on level ground (#20)	.76	5.05 (P = .06)	.82	2.76	.91	1.23

*If P value is not given, RRR is not significant at .1 level.

Table 12
Relative Risk Ratios (RRR) and probability levels for syndromes as described in the text. (RRR = $\frac{\text{RR Clev.}}{\text{RR Elyria}}$)

	CPS 1^{+*}	SOB 1^{+}	SOB + Wheeze 2^{+}	Wheeze 1^{+}	AOD 1^{+}	COPD
Males and Females	1.38 (P = .005)	1.04	1.23	1.09	.97	.98
Males	1.52 (P = .008)	1.00	1.37	.98	.969	.99
Females	1.29 (P = .062)	1.06	1.15	1.17	.973	.97

*see text for abbreviations

Table 13
Multiple Regression Summary for Females 18-35

Independent Variables N = 35

Age(yrs)	Ht(cm)	Wt(Kg)	LOC	SMK	SES 1	SES 2	SES 3
26.9 ± 4.7	162.6 ± 5.0	61.5 ± 10.9	.51 ± .5	.46 ± .50	.31 + .47	.31 ± .47	.37 ± .49

Dependent Variables - regression coefficients with levels of probability.

	Constant	Age(yrs)	Ht(cm)	Wt(Kg)	LOC	SES 1	SES 2	SES 3
FVC(ml)	5783.3	37.2(.03)	-34.4(.06)	34.1(.0002)	561.6(.004)	NS	NS	349.3(.07)
FEV$_1$(ml)	5060.3	26.2(.1)	-29.2(.1)	28.6(.001)	538.4(.005)	NS	NS	363.7(.06)
HFVC(ml)	-1930.8	27.6(.1)	23.4(.2)	15.2(.1)	323.0(.1)	NS	NS	266.5(.2)
HFEV$_1$(ml)	1275.4	23.6(.1)	NS	19.2(.01)	417.3(.03)	NS	NS	335.5(.08)
FEV$_1$/FVC	.881	NS	NS	NS	NS	-.029(.08)	-.024(.17)	NS
HFEV$_1$/HFVC	1.11	NS	-.001(.22)	NS	.027(.1)	-.021(.2)	-.03(.04)	NS
Amax$_{50}$(L)	1.5	.04(.2)	NS	.029(.06)	NS	-.56(.9)	-.81(.04)	NS
Hmax$_{50}$(L)	11.6	.12(.04)	-.07(.2)	.06(.03)	1.2(.04)	-.97(.07)	-.76(.2)	NS
Amax$_{75}$(L)	.31	NS	NS	.03(.03)	.36(.2)	-.3(.2)	NS	NS
Hmax$_{75}$(L)	1.0	NS	NS	.03(.06)	NS	-.6(.08)	-.56(.2)	NS
$\Delta\dot{V}_{max50}$	2.36	NS	NS	NS	NS	NS	-.7(.3)	NS
$\Delta\dot{V}_{max75}$	2.22	NS	NS	NS	NS	NS	NS	-.76(.3)
$V_{iso\dot{V}}$ (ml)	-4559.0	NS	34.4(.003)	-8.64(.09)	NS	NS	NS	NS

Table 14
Multiple Regression Summary for Males 18-35

Independent Variables N = 40

Age(yrs)	Ht(cm)	Wt(Kg)	LOC	SMK	SES 1	SES 2	SES 3
26.2 ± 3.7	176.7 ± 5.3	79.4 ± 12.6	.4 ± .5	.67 ± .47	.075 ± .26	.30 ± .46	.62 ± .49

Dependent Variables - regression coefficients with levels of probability.

	Constant	Age(yrs)	Ht(cm)	Wt(Kg)	LOC	SMK	SES 1	SES 2	SES 3
FVC(ml)	-1794.7	-69.4(.02)	49.1(.01)	NS	483.2(.02)	NS	-823.6(.04)	NS	NS
FEV_1(ml)	213.14	-59.9(.004)	31.7(.02)	NS	418.1(.005)	NS	-354.5(.2)	NS	NS
HFVC(ml)	-4509.5	-62.3(.02)	59.4(.002)	9.0(.2)	481.4(.01)	NS	NS	NS	NS
$HFEV_1$(ml)	-2531.7	-62.7(.006)	45.1(.006)	8.1(.2)	497.7(.004)	NS	NS	NS	NS
FEV_1/FVC	.849	NS	NS	NS	NS	NS	.12(.03)	-.02(.17)	NS
$HFEV_1$/HFVC	1.11	NS	-.001(.26)	NS	.01(.28)	NS	NS	NS	NS
$Amax_{50}$(L)	6.1	-.068(.2)	NS	NS	1.09(.009)	NS	NS	NS	.875(.03)
$Hmax_{50}$(L)	6.9	NS	NS	NS	.96(.07)	NS	NS	NS	1.24(.02)
$Amax_{75}$(L)	7.7	-.07(.009)	-.02(.2)	NS	.48(.02)	NS	NS	NS	.25(.2)
$Hmax_{75}$(L)	9.3	NS	-.04(.2)	NS	.55(.07)	NS	NS	NS	.51(.1)
$\Delta \dot{V}_{max50}$	-9.1	-.13(.2)	-.08(.2)	NS	NS	NS	NS	NS	NS
$\Delta \dot{V}_{max75}$	6.5	-.16(.1)	NS	NS	NS	NS	-1.5(.3)	NS	NS
$V_{iso\dot{V}}$(ml)	1580	-34.2(.1)	NS	NS	NS	NS	NS	276.2(.07)	NS

Table 15
Multiple Regression Summary for Males 36-50

Independent Variables N = 38

Age(yrs)	Ht(cm)	Wt(Kg)	LOC	SMK	SES 1	SES 2	SES 3
44.0 ± 4.2	175.1 ± 7.9	78.9 ± 14.7	.73 ± .44	.78 ± .41	.18 ± .39	.39 ± .49	.42 ± .5

Dependent Variables - regression coefficients with levels of probability.

	Constant	Age(yrs)	Ht(cm)	Wt(Kg)	LOC	SMK	SES 1	SES 2	SES 3
FVC(ml)	-4559.7	-54.6(.06)	67.37(.000)	NS	NS	NS	-439.6(.1)	NS	NS
FEV_1(ml)	-2808.8	-40.1(.1)	49.7(.000)	NS	NS	-281.2(.3)	-309.6(.2)	NS	NS
HFVC(ml)	-3998.4	-56.4(.03)	64.5(.000)	NS	NS	NS	NS	NS	NS
$HFEV_1$(ml)	-2839.3	-54.3(.05)	54.6(.000)	NS	NS	-322.1(.2)	NS	NS	NS
FEV_1/FVC	.805	NS	NS	NS	NS	NS	NS	.016(.2)	NS
$HFEV_1$/HFVC	.869	NS	NS	NS	NS	-.015(.28)	NS	NS	NS
$Amax_{50}$ (L)	-3.3	NS	.049(.1)	NS	NS	-.86(.1)	NS	NS	NS
$Hmax_{50}$ (L)	9.45	-.1(.3)	NS	.04(.1)	NS	NS	NS	NS	NS
$Amax_{75}$ (L)	1.83	-.03(.2)	NS	.01(.05)	NS	NS	NS	.20(.3)	NS
$Hmax_{75}$ (L)	2.61	-.045(.2)	NS	.02(.07)	NS	NS	NS	NS	NS
$\Delta\dot{V}max_{50}$	-2.60	.10(.2)	NS	NS	NS	NS	NS	.97(.1)	NS
$\Delta\dot{V}max_{75}$	7.62	.09(.2)	-.08(.1)	.05(.07)	NS	NS	NS	.76(.3)	NS
$V_{iso\dot{V}}$ (ml)	390.1	29.2(.1)	NS	NS	-192.2(.3)	NS	NS	NS	237.5(.1)

Table 16
Multiple Regression Summary for Females 36-50

Independent Variables N = 65

Age(yrs)	Ht(cm)	Wt(Kg)	LOC	SMK	SES 1	SES 2	SES 3
42.6 ± 4.7	161.2 ± 5.9	69.0 ± 13.7	.53 ± .5	.48 ± .5	.32 ± .47	.41 ± .49	.26 ± .44

Dependent Variables - regression coefficients with levels of probability.

	Constant	Age(yrs)	Ht(cm)	Wt(Kg)	LOC	SMK	SES 1	SES 2	SES 3
FVC(ml)	-2976.9	-42.1 (.000)	53.44(.000)	-5.42(.2)	NS	-146.32(.2)	184.4(.1)	NS	NS
FEV_1(ml)	-707.9	-42.4(.000)	34.1(.000)	NS	NS	-166.6(.08)	NS	NS	NS
HFVC(ml)	-1714.6	-35.1(.008)	42.1(.000)	NS	NS	-244.0(.04)	NS	NS	NS
HFEV_1(ml)	-26.9	-35.9(.004)	29.1(.003)	NS	NS	-242.5(.03)	NS	NS	NS
FEV_1/FVC	1.23	-.002(.06)	-.001(.05)	NS	NS	NS	-.02(.09)	NS	NS
HFEV_1/HFVC	1.37	-.001(.23)	-.002(.000)	.0007(.03)	NS	-.01(.17)	-.02(.03)	NS	NS
Amax_{50}(L)	5.97	-.05(.05)	NS	NS	NS	NS	NS	.33(.15)	NS
Hmax_{50}(L)	18.3	-.08(.1)	-.06(.1)	.02(.3)	.8(.08)	NS	NS	NS	NS
Amax_{75}(L)	3.44	-.04(.000)	NS	NS	NS	-.26(.02)	NS	NS	NS
Hmax_{75}(L)	8.47	-.07(.001)	-.02(.2)	NS	NS	-.4(.03)	NS	NS	NS
$\Delta\dot{V}\text{max}_{50}$	29.1	-.12(.17)	-.1(.2)	-.04(.2)	NS	-1.71(.04)	NS	-1.1(.2)	NS
$\Delta\dot{V}\text{max}_{75}$	26.2	-.12(.2)	-.09(.2)	-.05(.1)	NS	-1.59(.07)	1.4(.1)	NS	NS
$V_{\text{iso}\dot{V}}$(ml)	-3294.1	NS	24.7(.003)	NS	-290.1(.02)	NS	-160.9(.3)	134.6(.2)	NS

Table 17
Multiple Regression Summary for Males 51-75

Independent Variables N = 82

Age(yrs)	Ht(cm)	Wt(Kg)	LOC	SMK	SES 1	SES 2	SES 3
60.5 ± 6.4	171.0 ± 13.2	79.5 ± 15.9	.56 ± .49	.85 ± .35	.34 ± .48	.44 ± .50	.21 ± .42

Dependent Variables - regression coefficients with levels of probability.

	Constant	Age(yrs)	Ht(cm)	Wt(Kg)	LOC	SMK	SES 1	SES 2	SES 3
FVC (ml)	1607.2	-52.9(.001)	28.2(.000)	13.8(.04)	-327.8(.1)	-328.6(.2)	NS	NS	402.5(.08)
FEV_1(ml)	1445.9	-48.2(.000)	23.2(.000)	12.4(.02)	-279.4(.1)	-406.4(.08)	-243.3(.2)	NS	232.2(.3)
HFVC(ml)	1709.4	-44.2(.01)	25.8(.002)	12.4(.06)	-458.2(.03)	-358.4(.2)	NS	NS	367.9(.1)
$HFEV_1$(ml)	1850.7	-45.7(.004)	22.2(.003)	12.0(.05)	-407.7(.04)	-481.6(.05)	-240.6(.3)	NS	239.8(.3)
FEV_1/FVC	1.10	NS	-.002(.01)	.001(.001)	NS	NS	-.023(.06)	NS	NS
$HFEV_1$/HFVC	.715	-.001(.28)	.0007(.14)	.0004(.26)	.02(.14)	NS	NS	NS	NS
$Amax_{50}$(L)	.2	-.05(.09)	.03(.04)	.02(.2)	NS	-.65(.2)	NS	NS	.73(.1)
$Hmax_{50}$(L)	1.43	-.11(.03)	.04(.09)	.04(.06)	NS	NS	NS	NS	NS
$Amax_{75}$(L)	-1.59	-.02(.1)	.02(.02)	.01(.01)	NS	NS	NS	NS	NS
$Hmax_{75}$(L)	1.54	-.03(.005)	.009(.1)	.008(.07)	-.21(.2)	-.34(.08)	-.36(.08)	NS	NS
$\Delta\dot{V}max_{50}$	-3.22	.09(.06)	NS	NS	NS	NS	.78(.2)	NS	NS
$\Delta\dot{V}max_{75}$	-3.33	.1(.05)	NS	NS	-.85(.2)	NS	NS	NS	NS
$V_{iso\dot{V}}$(ml)	-2658.0	25.8(.01)	12.1(.006)	NS	-153.2(.2)	NS	NS	NS	218.7(.1)

Table 18
Multiple Regression Summary for Females 51-75

Independent Variables N = 167							
Age(yrs)	Ht(cm)	Wt(Kg)	LOC	SMK	SES 1	SES 2	SES 3
62.0 ± 6.6	158.8 ± .66	70.2 ± 13.3	.43 ± .49	.33 ± .47	.46 ± .49	.38 ± .49	.16 ± .37

Dependent Variables - regression coefficients with levels of probability.

	Constant	Age(yrs)	Ht(cm)	Wt(Kg)	LOC	SMK	SES 1	SES 2	SES 3
FVC(ml)	-1501.1	-28.5(.000)	42.2(.00001)	-10.3(.002)	NS	-252.1(.008)	NS	NS	NS
FEV_1(ml)	-146.6	-26.9(.000)	27.7(.00001)	-5.1(.08)	NS	-321.0(.000)	NS	NS	NS
MFVC(ml)	-1461.8	-22.3(.004)	39.3(.000)	-9.5(.01)	-143.4(.15)	-209.3(.04)	-195.1(.07)	NS	NS
$MFEV_1$(ml)	-339.2	-23.7(.001)	29.4(.000)	-4.8(.2)	NS	-294.8(.002)	-101.3(.3)	NS	NS
% FEV_1/FVC	1.10	-.001(.09)	-.002(.009)	.0008(.009)	.01(.18)	-.029(.001)	NS	NS	NS
$MFEV_1$/MFVC	1.14	-.001(.1)	-.001(.006)	.0009(.004)	.01(.1)	-.03(.000)	NS	NS	NS
$Amax_{50}$(L)	6.47	-.06(.000)	NS	.009(.2)	-.2(.3)	-.9(.000)	NS	NS	NS
$Hmax_{50}$(L)	10.01	-.1(.000)	NS	.02(.1)	NS	-1.5(.000)	NS	NS	NS
$Amax_{75}$ (L)	.78	-.02(.000)	.008(.07)	NS	NS	-.23(.000)	NS	NS	.14(.1)
$Hmax_{75}$ (L)	.847	-.02(.008)	.009(.2)	NS	NS	-.29(.008)	NS	NS	.19(.1)
$\Delta\dot{V}max_{50}$	17.13	NS	-.08(.07)	NS	NS	NS	.8(.2)	NS	NS
$\Delta\dot{V}max_{75}$	16.77	NS	-.08(.08)	NS	NS	NS	.8(.2)	NS	NS
$V_{iso\dot{V}}$ (ml)	650.5	NS	NS	NS	NS	78.7(.2)	NS	NS	-88.4(.2)

The nature of the differences in the lung function analysis are interesting and deserve further discussion. The He-O_2 mixture was used in these subjects because it was considered that the flow volume test would be quite sensitive to small airway obstruction (14). However, this proved not to be the case. In the age and sex categories where we found significant differences for pulmonary functions, $\Delta\dot{V}_{max50}$ or $\Delta\dot{V}_{max75}$ was not one of the significant variables. Even in the case of the 18-35 year old males where all of the air and He-O_2 values were significant the $\Delta\dot{V}_{max}$ data was not. At least in this work we conclude that the values of $\Delta\dot{V}_{max}$ are not sensitive to small airway changes but that the instantaneous flow values using He-O_2 are. However, the instantaneous flow values on He-O_2 are no more sensitive than the flow values in air. In considering the amount of time it takes to carry out the test and the amount of useful data, it does not seem like a worthwhile test to conduct in epidemiological studies of small airway diseases.

The value $\dot{V}_{isoV}$ has also been considered to be a very sensitive value to small airway obstruction (14). In our data this value only showed one location difference (males 36-50) but as seen in Table 13 through 18, it is the only variable that is significant or appears in that Table. In the males 51-75 it also shows up but at a .2 level of probability.

In conclusion these questionnaires and lung function data seem to indicate selective migration in these adult populations. It is understood that the sample sizes of the compared age groups are different and could influence the outcome of these data. Admittedly a combined sample size from both cities of 50 is not a large sample from which to draw such important conclusions; and it is on this sample size in the young group that we suggest selective migration. On the other hand in the older age groups the sample sizes are considerably larger and permit one to draw conclusions with more confidence.

There is one qualifying point that needs to be made. In the data reported it is interesting to note that the questionnaire responses of the young age group had RRR's which always exceeded 1.0 indicating greater risk in Cleveland. This was an objective evaluation on the part of the subject participating. Concomitantly the lung function evaluation also showed reduced pulmonary efficiency in the Cleveland residents. This was an objective evaluation on the part of the investigator. In a similar fashion the reverse situation applies to the older age groups where there is parity for the risks and lung function tests. It is felt that with these two variables, i.e., questionnaire and lung function tests, both showing similar trends there is a possible cause and effect relationship in this study. We suggest that air pollution could be producing the higher risks and reduced lung function efficiencies in Cleveland. It is also appreciated that testing each volunteer one time within the study design is a serious shortcoming in drawing such conclusions.

Methemoglobin (MetHb) and Carboxyhemoglobin (COHb) -

Table 19 shows the MetHb and COHb data. There are several points of interest in this table. First is that the MetHb values are significantly higher ($P < .01$) in the Elyria males and females when compared to the Cleveland males and females for both smoking and nonsmoking groups. This was a difficult problem for us to resolve because it was thought that there was a technical difficulty in analysis. But upon inquiring about water quality in the two cities it was discerned that the drinking water in Elyria had higher levels of sodium nitrate, than the drinking water in Cleveland. This also indicates that this technique for measuring MetHb is quite sensitive for detecting small changes in levels of MetHb.

COHb values for all categories of males, females, smokers and nonsmokers were significantly higher in Cleveland than Elyria.

In examining differences within a given city the smokers, male ($P < .01$) and females ($P < .02$) in Cleveland had higher MetHb values than nonsmokers. In Elyria this was not true. As would be expected, in both cities the smokers had significantly higher ($P < .01$) COHb values than the nonsmokers.

Table 19. Methemoglobin and carboxyhemoglobin for smoking and nonsmoking males and females in Cleveland and Elyria ($\bar{x}$ ± SE). Units are in % saturation of hemoglobin.

	Cleveland MetHb (% sat)	COHb (% sat)	Elyria MetHb (% sat)	COHb (% sat)
Male smokers	N=46 2.34±.26	N=31 7.43±.37	N=37 3.42±.25	N=28 6.27±.5
Female smokers	N=41 2.14±.28	N=44 6.04±.37	N=47 3.81±.24	N=34 4.82±.4
Male smokers	N=14 1.31±.21	N=8 3.21±.17	N=17 3.89±.21	N=10 2.00±.2
Female smokers	N=78 1.38±.13	N=57 2.87±.17	N=71 3.70±.22	N=46 1.86±.0

Trace Elements -

All of the trace elements in hair and blood were normal. The only significant differences found were found with Hg in the hair, i.e., the Hg values were higher in Elyria than Cleveland ($P < .05$). These data are shown in Tables 20 and 21.

ECG Analysis

The ECG's were independently coded by two individuals using the Minnesota Code (32) and a coder reliability check was performed (Table 22). The I. Item by Item Agreement refers to the agreement of each subcode in the larger category code - i.e., how many times a 4-1 is coded as 4-1 and not another 4 category. The II. Item by Category Agreement shows the agreement just within the large category, i.e., - a 4-1 and 4-2 are in agreement since they are in the same category (S-T depression). It can be seen that category reliability is higher than item by item reliability, as would be expected. Also the percentage agreement for serious ECG abnormalities like S-T depression, A-V conduction defects, T wave abnormalities are all at the 90% agreement level or better. However, during exercise the Q-QS category and S-T depression category agreement decreased to 40-50%. This was mainly due to muscle noise and baseline shift during exercise. Our ECG coding reliability between two coders compares favorably with other accuracy and reliability checks which use the Minnesota Code and was as high or higher in each of the major code categories as others reported (Ducimetiere and Richard, 33; Ivanova, 34; and Elgrishi et al., 35).

Table 20. Trace elements in hair from selected volunteers in Cleveland and Elyria, OH ($\bar{x}$ ± SE).

	Cd(μg/gm)	Hg(μg/gm)	Pb(μg/gm)
Elyria males and females (N=43)	.301 ± .05	.431 ± .06	4.01 ± 1.0
Elyria males (N=12)	.587 ± .13	.842 ± .18	8.56 ± 3.0
Elyria females (N=31)	.190 ± .04	.272 ± .02	2.25 ± .5
Cleveland males and females (N=49)	.284 ± .05	.350 ± .03	4.18 ± .7
Cleveland males (N=22)	.431 ± .10	.399 ± .05	6.12 ± 1.4
Cleveland females (N=27)	.164 ± .03	.310 ± .03	2.58 ± .4

Table 21. Trace elements in blood from selected volunteers in Cleveland and Elyria, OH ($\bar{x} \pm$ SE).

Elyria males and females	(N=50)	.373 ± .04	(N=49)	166.75 ± 9.4
Elyria males	(N=20)	.491 ± .08	(N=17)	203.94 ± 17.0
Elyria females	(N=30)	.294 ± .04	(N=32)	147.00 ± 9.7
Cleveland males and females	(N=49)	.534 ± .08	(N=48)	156.66 ± 9.6
Cleveland males	(N=19)	.551 ± .12	(N=21)	193.42 ± 14.5
Cleveland females	(N=20)	.519 ± .11	(N=27)	135.48 ± 9.2

Table 22. ECG coding reliability measured in the percentage of cases positive for a specific ECG category.

I. Item by Item Agreement

Items	Rest (cases)	%	Exercise (cases)	%	Immediate Post Exercise (cases)	%
Q,QS	8/11	73	4/10	40	———	
QRS axis	9/11	82	6/6	100	———	
R	20/22	91	17/18	94	———	
S-T	13/13	100	13/33	39	17/20	85
T	11/17	65	2/2	100	2/4	50
A-V	3/3	100	2/3	67	1/2	50
Vent. Cond.	———		———		———	
Arrhythmia	4/6	67	———		———	
Misc.	20/20	100	3/4	75	10/13	77

II. Item by Category Agreement

Category	Rest (cases)	%	Exercise (cases)	%	Immediate Post Exercise (cases)	&
Q, QS	11/11	100	4/10	40	———	
QRS	10/11	91	6/6	100	———	
R	21/22	95	17/18	94	———	
S-T	13/13	100	17/33	52	21/22	100
T	16/17	94	2/2	100	3/4	75
A-V	3/3	100	3/3	100	1/2	50
Vent. Cond.	———		———		———	
Arrhythmia	6/6	100	———		———	
Misc.	22/22	100	4/4	100	10/13	77

The following breakdown analysis has been divided into ECG findings at: rest, exercise, immediately after exercise and 3 minutes after exercise. A chi square analysis was performed on the frequency of occurrence of the following major categories: 1) Q, QS patterns, 2) axis deviation, 3) high R waves, 4) S-T depressions, 5) T wave changes, 6) A-V defects, 7) ventricular conduction defects, 8) arrhythmias and 9) miscellaneous changes.

Table 23 shows the age, height, and weight means by sex in each city and there were no significant differences in these parameters comparing each city by sex. Table 24 shows the frequency of each of the major drug types by sex of all the subjects in the study. Overall, females used medication more than males ($P < .01$) and subjects in Cleveland used more medication than Elyria subjects ($P < .04$).

Specifically, females used the following drugs significantly more than males: adrenergic blockers ($P = .004$, in Cleveland females), various types of tranquilizers ($P = .03$), antiinflammatory and analgesics ($P = .01$).

Limitations of Minnesota Code -

There are some well recognized limitations of ECG's in general (Higgins et al., 36; Ferris, 37) and the Minnesota Code specifically, which should be mentioned (Blackburn, 38; Blackburn et al., 27). In longitudinal studies the Q-QS patterns indicative of myocardial infarction can disappear in 3 months time (Williams, Draulans and De Geest, 39; Pyorala and

Table 23. Age, height, and weight of males and females in Cleveland and Elyria. ($\bar{x} \pm$ SD).

	Cleveland		Elyria	
	Males (n=92)	Females (n=207)	Males (n=114)	Females (n=179)
Age (yrs)	47.6 ±18.1	54.1 ±14.0	47.9 ±13.9	51.4 ±13.8
Height (cm)	172.1 ±12.5	159.8 ±6.4	174.4 ±6.7	160.2 ±5.9
Weight (kg)	79.9 ±15.6	71.6 ±15.2	79.1 ±15.3	66.4 ±12.3

Table 24. Percentage usage of various drugs in the Elyria and Cleveland populations.

Medication Analysis

Type of Medication		% Occurrence			
		Cleveland		Elyria	
		Males (n=94)	Females (n=213)	Males (n=116)	Females (n=193)
1.	Cardiac stimulants	7.4	4.7	3.4	5.2
2.	Vasodilators	7.4	4.2	6.0	6.2
3.	Adrenergic blockers	4.3	16.9	12.1	10.9
4.	Diuretics	12.8	9.9	6.9	11.9
5.	Tranquilizers	6.4	9.9	3.4	10.4
6.	Anti-inflammatory/analgesics	2.1	7.5	2.6	7.8
7.	Muscle relaxants	3.2	1.4	4.3	1.6
8.	Oral contraceptives/sex hormones	0	4.2	0	3.1
9.	Insulin, thyroxine and others	12.8	14.6	8.6	13.5
10.	No medication	63.0	52.0	71.6	59.1

Kentala, 40), but in our study this is not a factor since we are not predicting coronary heart disease and not conducting a longitudinal study. This should not present a bias in comparing the Cleveland-Elyria populations.

Also criticism has been aimed at coding errors (Rautahar, 41) interfering with calculations of disease prevalence especially when the incidence is low. However, our coding reliability is quite high for the major indicators of coronary ischemia. Also this type of error would not create a bias in one city sample over the other in our two city comparisons.

Another criticism has been that ECG changes may be due to noncardiac parameters (Ishikawa, 42) such as, height and weight. These factors affected Q and R amplitude and the ST-T area was increased with increased height and weight. Barun et al. (43) also found that the QRS and ST-T amplitude decreased with age. However, our data shows that age, height, and weight were not significantly different between the two cities. Therefore, this should not be a significant factor in explaining differences in electrocardiograms between the two cities.

To determine the power of the ECG in predicting abnormal pulmonary function values the data were applied to various multivariate statistical techniques. The first of these was multiple linear regression. This was carried out in order to determine which of the 32 independent variables (Table 25) were more effective in predicting pulmonary function values. From this analysis the best predictions, which in this case was 6, were then used in a Wilks discriminant analysis and the percent of those pulmonary function values accurately predicted reported. The six independent variables used were carboxyhemoglobin, methemoglobin, S-T depression at rest, high R waves during exercise, S-T depression during exercise, and T wave abnormalities during exercise.

Discriminant Analysis Summary

Table 26, 27, and 28 shows the results of the Wilks discriminant analysis. The basis for the discriminant function was to classify individuals into high or low vital capacity groups based on whether their vital capacity was above or below the average for the age group. In the discriminant analysis 6 variables were used as predictors out of a total of 32. These 6 were the independent variables which predicted the most variance of the groups. It is apparent from Tables 26, 27, and 28 that by using these discriminators it was possible to correctly

Table 25. Total listing of variables used in discriminant and multiple regression analyses on pulmonary functions.

Variable
Methemoglobin
Carboxyhemoglobin
Cadmium in blood
Mercury in blood
Selenium in hair
Mercury in hair
Arsenic in hair
Lead in hair
Cadmium in hair
Packyears of smoking
Location: Elyria or Cleveland
ECG-resting Q or QS pattern
" Axis deviation
" High R waves
" S-T depression
" T wave abnormality
" Arrhythmias
" Misc. (S-T elev.)
ECG-exercise Q or QS pattern
Axis deviation
High R waves
S-T depression
T wave abnormality
Arrhythmias
Misc. (S-T elev.)
Hemoglobin level
Education level
Less than 12 years education
12 years of education
Greater than 12 years education

Table 26. Wilks discriminant analysis for the males and females 18-35 years from Cleveland and Elyria combined.

Vital Capacity Predictors

Males N=26		Females N=18	
predictors		predictors	
1. MetHb	69.2% correctly classified	1. Exercise T wave	72.2% correctly classified
2. Exercise T wave			
3. Exercise S-T segment depression			

Forced Expiratory Volume Predictors

Males		Females	
1. Exercise R waves	88.4% correctly classified	1. Exercise T wave	72.2% correctly classified
2. Exercise T wave		2. CoHb	
3. MetHb			
4. Exercise S-T segment depression			

Table 27. Wilks discriminant analysis for the males and females 36-50 years from Cleveland and Elyria.

Vital Capacity Predictors

Males N=17		Females N=24	
predictors 1. Exercise S-T segment depression 2. CoHb 3. Exercise R waves	70.6% correctly classified	predictors 1. CoHb 2. Exercise S-T segment depression	66.7% correctly classified

Forced Expiratory Volume Predictors

Males		Females	
1. Exercise S-T segment depression 2. CoHb	88.2% correctly classified	1. CoHb 2. Exercise R waves 3. Exercise S-T segment depression	66.7% correctly classified

Table 28. Wilks discriminant analysis for the males and females 51-75 years from Cleveland and Elyria.

Vital Capacity Predictors

Males N=24		Females N=61	
predictors 1. Exercise R waves 2. MetHb 3. Exercise S-T segment depression	75% correctly classified	predictors 1. Exercise S-T segment depression 2. Rest S-T segment depression 3. Exercise R waves 4. Rest T wave 5. CoHb	68.9% correctly classified

Forced Expiratory Volume Predictors

Males		Females	
1. MetHb 2. Exercise S-T segment depression 3. CoHb	79.2% correctly classified	1. Exercise S-T segment depression 2. Rest S-T segment depression 3. CoHb	75.4% correctly classified

classify individuals into high/low vital capacity by age with a high degree of accuracy.

A similar analysis was performed using high/low FEV_{1sec}.

The results of the discriminant analysis show that as a group the males have a higher percentage of cases correctly classified using the same variables as compared to the females (78.4% vs. 70.4%, respectively). In general, the variables predicted more accurately FEV than they did VC (78.4 vs. 70.4%, respectively).

The most common predictor of FEV for males and females combined was S-T segment depression during exercise and carboxyhemoglobin. The most common predictor of VC for both sexes was also exercise S-T segment depression. Causal relationships really cannot be inferred from these data but it is interesting to speculate that increased levels of CO could elevate carboxyhemoglobin which is associated with S-T changes and reduced cardiac function could compromise pulmonary function.

Analysis by sex and age shows that FEV was predicted most accurately for the males ages 18-35 yr (88.4%) and males ages 36-50 (88.2%). The poorest FEV or VC predicted were the females ages 36-50 yrs (66.7%). Examination of each age and sex group showed that the single variable that was used first was often in the discriminant analysis was exercise S-T segment depression.

In summary, it appears that in future pulmonary health population surveys it is beneficial to measure selected ECG variables during exercise. There appears to be a significant proportion of the population that show decreased pulmonary function along with ECG abnormalities, especially S-T segment depression.

TYPING GUIDE SHEET
BEGIN FIRST LINE OF TEXT HERE
CENTER OF PAGE
TOP OF IMAGE AREA
DROPPED HEAD, BEGIN SECTIONS HERE
6-1/2"
9-1/8"
BEGIN LAST LINE OF TEXT
BOTTOM OF IMAGE AREA: OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
3/8"
PAGE NUMBER
EPA-287 (Cin.)
(4-76)

APPENDIX 1

THE UNIVERSITY OF AKRON
AKRON, OHIO 44325

Department of Biology
Phone: (216) 375-7155

To Whom It May Concern:

This letter and consent form are provided to give you a quick, general idea of the scope of our work. Naturally, if you you have any questions our staff will be more than happy to help you with detailed information.

Very briefly, we are seeking volunteers to assist us in answering a number of questions about respiratory problems in northeastern Ohio. By volunteering to participate, you will be one of several thousand providing us with information and data that we hope will answer these questions.

Our research procedure will include numerous tests, the results of which will be available to you. We will also be more than happy to discuss the results with you. We have calculated that the cumulative cost of all the tests that we will conduct on each subject will be about $400. This, of course, will not cost you one cent. We only ask that if you dedide to participate that you give us your confidence and complete cooperation. We in turn will give you the benefits of our expertise and provide you the opportunity to understand a little more about yourself. You will find many of the aspects of the study both revealing and fascinating. Finally, the total value of the project to all individuals residing in urban communities will be invaluable and will go a long way in solving many lung related complications.

All of the work has been reviewed, funded and is sponsored by the United States Environmental Protection Agency (EPA), Washington, D.C. The individuals primarily involved in setting up and carrying out this project are Richard Mostardi, Ph.D. and Daniel Ely, Ph.D., from The University of Akron. If you have any questions concerning any aspect of this project, please do not hesitate to ask. We will be more than happy to provide additional information.

We look forward to having you participate.

Sincerely,

Richard A. Mostardi, Ph.D.
Associate Professor

TYPING GUIDE SHEET
BEGIN FIRST LINE OF TEXT HERE
CENTER OF PAGE
TOP OF IMAGE AREA
DROPPED HEAD BEGIN SECTIONS HERE

Informed Consent

The proposed research project is to study respiratory disease in northeastern Ohio. It will include approximately 2,000 volunteers from Lorain-Elyria, Cleveland, and Akron. Each subject will undergo a variety of tests which include the following:

1. Two questionnaires to gain information about smoking habits, incidence of respiratory disease, general information and stress factors.
2. Lung function tests, commonly called pulmonary functions, which simply involve expiring or blowing air into a measuring device.
3. Hair sample (about 25 strands) for some trace metals, such as beryllium, mercury, and antimony.
4. Electrocardiogram before, during, and after a low level exercise test. This will be a test which involves riding a stationary bicycle for a few minutes.
5. Blood tests and blood pressure.

All of the data that will be collected will be coded, and kept in strictest confidence, and will only be used within the framework of this study. Upon request, the subject may inspect his or her data at any time, along with an explanation of any of the values.

The risks associated with exercise tests, lung function tests, and hair collection are minimal. Exercise tests can sometimes produce dizziness, loss of balance and occasional irregular beats. However, these tests will be monitored very carefully, and if at any time during the test any irregularities appear, the test will be terminated. The subject

BEGIN LAST LINE OF TEXT
BOTTOM OF IMAGE AREA OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
3/8"
PAGE NUMBER
EPA-287 (Cin.)
(4-76)

may also stop the test at any time due to a feeling of discomfort. Tests of this type are carried out routinely throughout the world and are considered very safe. Blood will be drawn from an arm vein using sterile technique. This will be performed by registered medical technologists, and again, risks are minimal.

All of these tests will be conducted and supervised by qualified persons. All of the apparatus and procedures have been thoroughly tested.

Any subject participating in this study may withdraw at any time without any penalty whatsoever. A subject may also decline to participate in any of the particular aspects of the study without penalty. It is important to volunteer even though you may not want to participate in any particular phase - simply refuse that one phase and complete the rest of the tests.

Each subject should also be aware that signing this form does in no way waive any legal rights or release The University of Akron from liability for negligence.

We feel that your participation in the study will provide us with an opportunity to determine what kinds of respiratory problems are most prevalent in northeastern Ohio. Knowing what diseases are most common, we feel that the medical community will be in a better position to determine the cause and effective treatment. Ultimately, it is hoped that the total standards of respiratory health will be better understood and make northeastern Ohio a better place to live.

Subject________________________

Witness________________________

Date____________

University of Akron Research Study on Respiratory Disease

Adult Questionnaire

Please answer the questions in this questionnaire as completely as possible. The questions can be answered by circling the number of the best answer or by filling in a blank with a number or word.

Example: What is your sex? 1. male
2. female

If you have any problems in answering any of the questions, a member of the staff will be happy to help you.

ALL INFORMATION WILL BE KEPT CONFIDENTIAL

Name________________________________QID______

Address______________________________________

Phone_______________________________

Social Security No.____-____-____

Date of Birth____________________

TYPING GUIDE SHEET
BEGIN FIRST LINE OF TEXT HERE
CENTER OF PAGE
TOP OF IMAGE AREA
DROPPED HEAD, BEGIN SECTIONS HERE

1. What is your full name?____________________________________

2. Date questionnaire completed______ ______ ______
(month) (day) (year)

3.	What sex are you?	1. Male 2. Female
4.	What is your ethnic group or ancestry?	1. White 2. Mexican-American 3. Black 4. Indian 5. Oriental 6. Other
5.	What is your marital status?	1. Married 2. Separated 3. Never married 4. Widowed 5. Divorced
6.	How many years of formal education or schooling have you had? (For example, completion of high school = 12)	__________(years)
7.	What is your birthdate?	__/__/___ mo. day yr.
8.	How long have you lived in your present city or town?	1. 1-5 years 2. 5-10 years 3. 10 or more years
9.	How long have you lived at your present address?	1. 1-5 years 2. 5-10 years 3. 10 or more years
10.	Do you anticipate moving from your present address in the next year?	1. YES 2. NO
11.	Do you usually cough first thing in the morning in bad weather? (If you usually cough in the morning regardless of the weather, circle YES)	1. YES 2. NO
12.	Do you usually cough other than in the morning in the bad weather? (If you usually cough regardless of	1. YES 2. NO

BOTTOM OF IMAGE AREA OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
BEGIN LAST LINE OF TEXT
PAGE NUMBER

12. (continued)

the weather, circle YES)	
If your answer is YES to either questions 11 or 12, proceed to a:	
a. Do you cough on most days for as much as 3 months of the year?	1. YES 2. NO
b. For how many years have you had this cough?	1. Less than 2 years 2. 2-5 years 3. More than 5 years
c. Do you cough more or less now than you did two years ago?	1. More 2. Less 3. No change
d. During the past two years, have you seen a doctor about your cough?	1. YES 2. NO
13. Do you usually bring up phlegm, sputum, or mucous from your chest first thing in the morning in the bad weather? (If you usually bring up phlegm, sputum, or mucous from your chest in the morning regardless of the weather, circle YES)	1. YES 2. NO
14. Do you usually bring phlegm, sputum, or mucous from your chest at other times during the day or night in the bad weather? (If you usually bring up phlegm, sputum, or mucous from your chest, regardlesss of the weather, circle YES)	1. YES 2. NO
If your answer is YES to either question 13 or 14, proceed to a:	
a. Do you bring up phelgm, sputum, or mucous from your chest on most days for as much as three months of the year?	1. YES 2. NO
b. For how many years have you raised phlegm, sputum, or mucous from your chest?	1. Less than 2 years 2. 2-5 years 3. More than 5 years

	c.	Do you raise more or less phlegm, sputum, or mucous from your chest now than you did two years ago?	1. More 2. Less 3. No change
	d.	During the past two years, have you seen a doctor about this condition?	1. YES 2. NO
15.		Does your chest ever sound wheezy or whistling?	1. YES 2. NO
		If your answer is YES, proceed to 15 a:	
	a.	Do you get this with colds?	1. YES 2. NO
	b.	Do you get this even when you don't have a cold?	1. YES 2. NO
	c.	Do you get this on most days?	1. YES 2. NO
	d.	During the past year, has your wheezing or whistling improved, worsened, or stayed the same?	1. Improved 2. Worsened 3. Stayed the stame
	e.	How old were you when you first started wheezing?	_____(age)
16.		Have you ever had attacks of shortness of breath with wheezing?	1. YES 2. NO
		If your answer is YES, proceed to 16 a:	
	a.	Do you get this with colds?	1. YES 2. NO
	b.	Do you get this even when you don't have a cold?	1. YES 2. NO
	c.	During the past year, how many attacks of shortness of breath with wheezing did you have?	1. None 2. A few (1-3) 3. Several (4-10)

16 c. (continued)

	4. Many (13 or more) 5. Almost every day
d. How old were you when you had your first such attack?	______(age)
e. How old were you when you had your last such attack? (If you still have attacks, indicate your present age)	______(age)
17. Are you more short of breath than most people your age?	1. YES 2. NO
18. Are you troubled by shortness of breath when hurrying on level ground or walking up a slight hill?	1. YES 2. NO
19. Do you get short of breath walking with other people of your own age on level ground?	1. YES 2. NO
20. Do you have to stop for breath while walking at your own pace on level ground?	1. YES 2. NO
21. Did you have any respiratory trouble before age 16?	1. YES 2. NO
22. During the past three years, how much trouble have you had with illnesses such as chest colds, bronchitis, or pneumonia? (Does not refer to head colds)	1 2 3 4 5 some a great deal (Circle appropriate number)
23. During the past three years, how often were you unable to do your usual activities because of illnesses such as chest colds, bronchitis, or pneumonia? (Does not refer to head colds)	1. Never 2. During one such illness 3. During 2-5 such illnesses 4. During 6 illnesses or more

TYPING GUIDE SHEET
BEGIN FIRST LINE OF TEXT HERE
CENTER OF PAGE
TOP OF IMAGE AREA
DROPPED HEAD BEGIN SECTION HERE

24. Do you think you have ever had any of these chest disorders: asthma, any kind of bronchial trouble, emphysema?	1. YES 2. NO
25. Have you ever seen a doctor for asthma?	1. YES 2. NO
If your answer is YES, proceed to 25 a:	
a. During the past year, have your symptoms improved, worsened, or stayed the same?	1. Improved 2. Worsened 3. Stayed the same
b. During the past year, have you had a period as long as two weeks in which you had no breathing problems at all even with exercise?	1. YES 2. NO
c. How quickly are your attacks usually relieved by treatment?	1. Within minutes 2. Within hours 3. Within days 4. Not relieved 5. No treatment used
26. Have you ever seen a doctor for chronic bronchitis?	1. YES 2. NO
If your answer is YES, proceed to 26 a:	
a. During the past year, have your symptoms improved, worsened, or stayed the same?	1. Improved 2. Worsened 3. Stayed the same
b. Have you had medication or treatment for it?	1. YES 2. NO
27. Have you ever had any of the following (If uncertain circle NO):	
a. emphysema	1. YES, I still have it 2. YES, but I no longer have it 3. NO

BEGIN LAST LINE OF TEXT
BOTTOM OF IMAGE AREA OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
3/8"
PAGE NUMBER
EPA-287 (Cin.)
(4-78)

b. bronchiectasis

1. YES, I still have it
2. YES, but I no longer have it
3. NO

c. sinus trouble

1. YES, I still have it
2. YES, but I no longer have it
3. NO

d. pneumonia or bronchopneumonia

1. YES, I still have it
2. YES, but I no longer have it
3. NO

e. tuberculosis

1. YES, I still have it
2. YES, but I no longer have it
3. NO

f. valley fever (coccidiodomycosis)

1. YES, I still have it
2. YES, but I no longer have it
3. NO

g. histo (histoplasmosis)

1. YES, I still have it
2. YES, but I no longer have it
3. NO

h. any other respiratory disease

1. YES
2. NO

If YES, please specify___________________

28. How long have you been employed at your current occupation?

1. 1-5 years
2. 5-10 years
3. 10 or more years

29. Have you in the past worked in a dusty job or where there has been irritating gas, chemical fumes, or smoke?

1. YES
2. NO

TYPING GUIDE SHEET
BEGIN FIRST LINE OF TEXT HERE
CENTER OF PAGE
TOP OF IMAGE AREA
DROPPED HEAD BEGIN SECTIONS HERE

If your answer is YES, proceed to 29 a:

a. How many years were you employed there?
   1. 1-5 years
   2. 5-10 years
   3. 10 or more years

b. Was the exposure to the irritating gas, chemical fumes, smoke or dust mild, moderate or severe?
   1. Mild
   2. Moderate
   3. Severe

c. How many different companies have you worked for in the last 10 years?
   ____(number)

30. Do you now smoke cigarettes?
   1. YES
   2. NO

If your answer is YES, proceed to 30 a:

If your answer is NO, proceed to question 31.

a. Do you inhale?
   1. YES
   2. NO

b. Do you smoke cigarettes with filters?
   1. With filters
   2. Without filters
   3. Both with and without filters

c. How many cigarettes do you usually smoke each day at the present time? (Please give best estimate: one pack contains 20 cigarettes)
   ____number per day

d. How old were you when you began to smoke cigarettes?
   ______(age)

e. What is the usual number of cigarettes you have smoked per day since you began to smoke? (Please give best estimate: one pack contains 20 cigarettes)
   ____number per day

f. Are you smoking less now than two years ago?
   1. YES
   2. NO

BEGIN LAST LINE OF TEXT
BOTTOM OF IMAGE AREA OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
3/8"

PAGE NUMBER
EPA-287 (Cin.)
(4-76)

g. If so, how many are you smoking now? ____number per day

If you have completed this section, skip question 31 and go to question 32.

31. If you do not smoke cigarettes now, did you ever smoke them regularly or occasionally?

1. Never
2. Regularly
3. Occasionally

If your answer is regularly or occasionally, proceed to question 31 a:

a. What was the usual number of cigarettes you smoked per day? (Please give best estimate: one pack contains 20 cigarettes) ____number per day

b. Did you inhale?

1. YES
2. NO

c. How old were you when you began to smoke cigarettes? ______(age)

d. How old were you when you stopped smoking cigarettes regularly? ______(age)

e. Were you influenced to stop because you had a cough, wheezing, or shortness of breath?

1. YES
2. NO

32. Do you now smoke pipes or cigars?

1. YES
2. NO

If your answer is YES, proceed to 32 a:

If your answer is NO, proceed to question 33.

a. How many pipesful or cigars do you usually smoke each day? ____number per day

b. How old were you when you first smoked? ______(age)

c. Do you usually inhale when you smoke either pipes or cigars?	1. YES 2. NO
(If you have completed this section, skip question 33 and go to question 34).	
33. If you do not smoke cigars or pipes now, did you ever smoke them regularly or occasionally?	1. Never 2. Regularly 3. Occasionally
If your answer is regularly or occasionally, proceed to 33 a:	
a. How many pipesful or cigars did you usually smoke each day?	____number per day
b. How old were you when you first smoked pipes or cigars?	______(age)
c. How old were you when you stopped smoking pipes or cigars?	______(age)
d. Did you usually inhale when you smoked either pipes or cigars?	1. YES 2. NO
34. Do you ever have pain or discomfort in your chest brought on by exertion or excitement and is relieved by rest?	1. YES 2. NO
35. Have you ever been told by your doctor that you had angina or angina pectoris?	1. YES 2. NO
36. Do you have to stop to catch your breath while walking up one (1) flight of stairs?	1. YES 2. NO
37. Have you ever been hospitalized for a heart attack?	1. YES 2. NO
38. Are you currently taking any medication?	1. YES 2. NO

39. If YES to question 38, what is the name of the medication?________________________________

TYPING GUIDE SHEET
BEGIN FIRST LINE OF TEXT HERE
CENTER OF PAGE
TOP OF IMAGE AREA
DROPPED HEAD BEGIN SECTIONS HERE
BEGIN LAST LINE OF TEXT
BOTTOM OF IMAGE AREA OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
3/8"
PAGE NUMBER
EPA-287 (Cin.)
(4-76)

APPENDIX 2

Name ______________ ID ________ Age ________ Sex ________

Date ________ Site ________ HR_{Rest} ________ HR_W ________

Work ________ Duration ________ Medication ________

Calib Rest I Rest II Rest III

Exercise I Exercise II Exercise III

Immed. Post I Immed. Post II Immed. Post III

3 min. Post I 3 min. Post II 3 min. Post III

ID

Rest aVR
Rest aVL
Rest aVF

Exercise aVR
Exercise aVL
Exercise aVF

Immed. Post aVR
Immed. Post aVL
Immed. Post aVF

3 min. Post aVR
3 min. Post aVL
3 min. Post aVF

ID ________

Rest V_5

Exercise V_5

Immed. Post V_5

3 min. Post V_5

EKG Checklist

I.D.______________

RESTING

- Q and QS patterns
  - 1-1-1
  - 1-1-2
  - 1-1-3
  - 1-1-4
  - 1-1-5
  - 1-2-1
  - 1-2-2
  - 1-2-3
  - 1-2-4
  - 1-2-5
  - 1-2-6
  - 1-3-1
  - 1-3-3
  - 1-3-4
  - 1-3-5
  - 1-3-6
- QRS axis deviation
  - 2-1
  - 2-2
  - 2-3
  - 2-4
  - 2-5
- High amplitude R waves
  - 3-1
  - 3-3
- ST junction (S) and segment depression
  - 4-1
  - 4-2
  - 4-3
  - 4-4
- T-wave items
  - 5-1
  - 5-2
  - 5-3
  - 5-4
- A-V conduction defection
  - 6-1
  - 6-2
  - 6-3
  - 6-4
  - 6-5
- Ventricular conduction defect
  - 7-1
  - 7-2
  - 7-4
- Arrhythmias
  - 8-0
  - 8-1
  - 8-2
  - 8-3
  - 8-4
  - 8-5
  - 8-6
  - 8-7
  - 8-8
  - 8-9
- Miscellaneous items
  - 9-0
  - 9-1
  - 9-2
  - 9-3
  - 9-5
  - 9-8

EXERCISE

- Q and QS patterns
  - 1.1.1
  - 1.1.2
  - 1.1.3
  - 1.1.4
  - 1.1.5
  - 1.2.1
  - 1.2.2
  - 1.2.3
  - 1.2.4
  - 1.2.5
  - 1.2.6
  - 1.3.1
  - 1.3.3
  - 1.3.4
  - 1.3.5
  - 1.3.6
- QRS axis deviation
  - 2.1
  - 2.2
  - 2.3
  - 2.4
  - 2.5
- High amplitude K waves
  - 3.1
  - 3.3
- ST depressions
  - 4.1
  - 4.3
  - 4.4
  - 4.5
  - 4.6
  - 4.7
- T wave items
  - 5.1
  - 5.2
  - 5.3
  - 5.4
- A-V conduction defect
  - 6.1
  - 6.2
  - 6.3
  - 6.4
  - 6.5
- Ventricular conduction defect
  - 7.1
  - 7.2
  - 7.4
- Arrhythmias
  - 8.1
  - 8.2
  - 8.3
  - 8.4
  - 8.5
  - 8.6
  - 8.7
  - 8.8
  - 8.9
- Miscellaneous items
  - 9.1
  - 9.2
  - 9.3
  - 9.4
  - 9.6
  - 9.7
- Ectopic beats
  - 10.1
  - 10.2
  - 10.3
  - 10.4
  - 10.5
  - 10.6
  - 10.7
  - 10.8
  - 10.9

EKG Checklist (continued)

I.D.______________

DRUG CODE
17.0
17.1
17.2
17.3
17.4
17.5
17.6
17.7
17.8
17.9
POST EXERCISE
Immediate
S-T items
11-1
11-2
11-3
11-4
11-5
11-6
11-7
11-8
11-9
T items
12-1
12-2
12-3
12-4
12-5
12-6
12-7
12-8
A-V conduction
13-1
13-2
13-3
13-4
13-5
13-6
13-7
Ventricular
condition
14-1
14-2
14-4
14-5
14-6
14-7

Arrhythmias
15-1
15-2
15-3
15-4
Miscellaneous
items
16-1
16-2
16-3
POST EXERCISE
3 minutes
S-T items
11-1
11-2
11-3
11-4
11-5
11-6
11-7
11-8
11-9
T items
12-1
12-2
12-3
12-4
12-5
12-6
12-7
12-8
A-V conduction
13-1
13-2
13-3
13-4
13-5
13-6
13-7
Ventricular
conduction
14-1
14-2
14-4
14-5
14-6
14-7
Arrhythmias
15-1
15-2
15-3
15-4

Miscellaneous
items
16-1
16-2
16-3

COMMENTS:

APPENDIX 3

QUESTIONNAIRE B

General Instructions

There are three parts to this questionnaire and your honesty and cooperation are fully appreciated. All information in this questionnaire will be confidential between you and the professional personnel involved in this study. If you have any questions, please ask the person supervising the questionnaire. When you have completed all 3 parts hand it in to the researchers.

Thank you for your cooperation.

Date________

Code_________________________Age______Sex: Male______
Female____

Ethnic background (German, Slovenian, etc.)________________

1. Where were you born?___________________________________
City or Town State

2. Did you grow up there or in some other place?

____Same place

____Other____
City or Town State

3. Are you at present

____Married

____Widow/Widower

____Separated

____Divorced

____Single?

Date of your present marriage__________________

4. Occupation_____________________________________

5. Years of education: Completed through or less than 8th grade______
Completed through 9th grade______
Completed some high school______

Completed high school___________
Completed some college__________
Completed college (4 years)_____
Completed graduate training_____

PART I

SRLC

Instructions: Please check (✓) the appropriate box on the answer sheet depending on whether or not the indicated life event happened to you in the last 6 months. Example: item #12 is Pregnancy. If you were pregnant in the last 6 months, place a check (✓) in the "yes" column:
Yes
✓

Life Event	Yes	No
1. Death of spouse or companion	1.	
2. Divorce	2.	
3. Marital separation or engagement breakup	3.	
4. Jail term	4.	
5. Death of close family member	5.	
6. Personal injury or illness	6.	
7. Marriage	7.	
8. Fired at work	8.	
9. Marital readjustment	9.	
10. Voluntarily stopped working	10.	
11. Change in health of family member	11.	
12. Pregnancy	12.	
13. Sexual difficulties	13.	
14. Gain of new family member	14.	
15. Business readjustment	15.	
16. Change in financial state	16.	
17. Death of close friend	17.	
18. Change to different line of work	18.	
19. Change area of major study at school	19.	

TYPING GUIDE SHEET
BEGIN FIRST LINE OF TEXT HERE
CENTER OF PAGE
TOP OF IMAGE AREA
DROPPED HEAD: BEGIN SECTIONS HERE
BEGIN LAST LINE OF TEXT
3/8"
BOTTOM OF IMAGE AREA OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
PAGE NUMBER

Life Event		Yes	No
20. Change in number of arguments with spouse or companion	20.		
21. Mortgage over $10,000	21.		
22. Foreclosure of mortgage or loan	22.		
23. Change in responsibilities at work or school	23.		

Continue to PART II

PART II

MTJTA

Instructions:

Decide how each question applies to you. Record your decision by making a mark in the column which best indicates your answer. If you change an answer, please erase your first mark completely. Try to give a definite "yes" or "no" response.

Mark your answers by putting a check (✓) in one of the columns on the right: "yes", "no", or "undecided". Please answer each question and avoid the "undecided" category as much as possible. Example: Do you often feel happy? [✓ Yes] No Undecided

QUESTIONS

		Yes	No	Undecided
1. Do you have a marked influence on the thinking of family and associates?	1.			
2. Are you apt to make thoughtless unfeeling remarks?	2.			
3. Do you often feel left out or unwanted?	3.			
4. Do you prefer to be a follower rather than a leader in group activities?	4.			
5. Are you free from racial and religious prejudice?	5.			

BEGIN FIRST LINE OF TEXT HERE
TYPING GUIDE SHEET
CENTER OF PAGE
TOP OF IMAGE AREA
DROPPED HEAD: BEGIN SECTIONS HERE

		Yes	No	Undecided
6. Do you often feel disillusioned about life?	6.			
7. Do you take the initiative in making arrangements for family outings and vacations?	7.			
8. Do you seek to keep peace at any price?	8.			
9. Are you understanding when someone is late for an appointment?	9.			
10. Are you hopeful and optimistic about the future?	10.			
11. Do you have phobias or a deeply disturbing fear of any object, place or situation?	11.			
12. Does anyone ever complain that you are "bossy" or unreasonable?	12.			
13. When you offer a suggestion is it apt to be more helpful than critical?	13.			
14. Are you highly competitive in games, business or personal relations?	14.			
15. Do you have a quick temper?	15.			
16. Do you like to be in charge and supervise others?	16.			
17. Are there times when you feel discouraged or despondent over lack of progress or accomplishments?	17.			
18. Are you inclined to be argumentative?	18.			
19. Are you so self-assured that at times it is annoying even to friends?	19.			
20. Do you feel that life is very much worth living?	20.			

BEGIN LAST LINE OF TEXT
BOTTOM OF IMAGE AREA. OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
3-2"

PAGE NUMBER
EPA-287 (Cin.)
(4-70)

TYPING GUIDE SHEET
BEGIN FIRST LINE OF TEXT HERE
CENTER OF PAGE
TOP OF IMAGE AREA
DROPPED HEAD, BEGIN SECTIONS HERE

			Yes	No	Undecided
21.	Are you inclined "to tell people off"?	21.			
22.	Would you prefer to accept an unfair situation rather than complain?	22.			
23.	Do you have a deep respect for all human beings?	23.			
24.	Do you tend to be impatient with someone who is frequently ill?	24.			
25.	Do you need encouragement and approval in order to work effectively?	25.			
26.	Are you bothered at times by feeling unappreciated or by the idea that "nobody cares"?	26.			
27.	Do you stand up for your rights?	27.			
28.	Are you apt to be sarcastic when annoyed with someone?	28.			
29.	Do you like to let people know where you stand on issues?	29.			
30.	Do you often dwell on past misfortunes?	30.			
31.	Do you feel contempt for men who seem unable to make a living?	31.			
32.	Are you self-confident in most undertakings?	32.			
33.	Are you often so low in spirits as to be close to tears?	33.			
34.	Do you tend to rely on others when there are decisions to be made?	34.			
35.	Are you frequently depressed because of personal problems?	35.			
36.	Do you find it easy to give way to wishes of others?	36.			

9-1/8"
BEGIN LAST LINE OF TEXT
BOTTOM OF IMAGE AREA OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
3/8"

EPA-287 (Cin.)
(6-78)

TYPING GUIDE SHEET
BEGIN FIRST LINE OF TEXT HERE
CENTER OF PAGE
TOP OF IMAGE AREA
DROPPED HEAD, BEGIN SECTIONS HERE
9-1/2"
BEGIN LAST LINE OF TEXT
3/8"
BOTTOM OF IMAGE AREA, OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
PAGE NUMBER
EPA-287 (Cin.)
(4-76)

		Yes	No	Undecided
37. When deeply disturbed about something, have you ever contemplated suicide?	37.			
38. Do you often try to convert someone to a particular point of view?	38.			
39. Are you considered lenient and easy-going?	39.			
40. Are you often troubled by a lack of self-confidence?	40.			
41. Do you insist on prompt obedience?	41.			
42. Do you tend to dominate those around you?	42.			
43. Are you quick to forgive a mistake and overlook a discourtesy?	43.			
44. Are you easily taken advantage of by others?	44.			
45. Are you easily disheartened by criticism?	45.			
46. Do you like to speak in public and enjoy the challenge of debate?	46.			
47. Do you often have the "blues" or feel downhearted for no apparent reason?	47.			
48. Are you overly critical of some member of the family?	48.			
49. Do you at times suffer extreme physical exhaustion resulting from emotional exhaustion?	49.			
50. Do you often make such blunt, cutting comments that someone's feelings are hurt?	50.			
51. Are you very emphatic and forceful in voice and manner?	51.			

TYPING GUIDE SHEET

		Yes	No	Undecided
52. Are you superior or overbearing in attitude toward others?	52.			
53. Do you smile or laugh a great deal?	53.			
54. Do you often feel discouraged because of a sense of inferiority?	54.			
55. Are you slow to complain when inconvenienced or imposed upon?	55.			
56. Do you find it difficult to say "no" to a persuasive salesman?	56.			
57. Do you have periods of ideleness when it is difficult to find any reason for either physical or mental effort?	57.			
58. Do you often feel depressed by memories of childhood or other past experiences?	58.			
59. Do you have periods of depression which last for several days or more without apparent reason?	59.			

Continue on to PART III

PART III

LAQ

Instructions:

Select the best answer and circle the appropriate letter on the questionnaire. Do the best you can and answer every question. Example:
1. Approximately how many friends do you have? a) none b) 1 or 2 c) 3-5 d) 6-10 e) more than 10. If you have 8 friends, then mark answer d.

1. Approximately how many friends do you have? a) none b) 1 or 2 c) 3-5 d) 6-10 e) more than 10

2. Of these friends how many were really close friends in whom you could confide? a) none b) 1 c) 2-4 d) 5-10 e) more than 10

EPA-287 (Cin.)
(4-76)

3. What were your principal contacts with them? (List all which apply)
   a) school or school sponsored activity
   b) work or work related activity
   c) church activities
   d) family get-togethers
   e) neighborhood
   f) organized recreation

4. If you belonged to one group, or had one friend with whom you did many things, did you, as a pair or group?
   a) participate with others outside the group in various activities
   b) do most things together usually excluding others
   c) do almost everything together, excluding all others

5. I live most of the year: a) in a house b) apartment c) with another family in a house d) with another family in an apartment e) other

6. I live with: a) one other person b) two other people c) 3-4 other people d) more than 4 e) by myself

7. About how many people who live in your neighborhood would you recognize by sight if you saw them in a large crowd? a) none b) some c) many d) almost all

8. How often do you visit with your neighbors?
   a) never b) rarely c) sometimes d) often

9. How often do you have friends in where you live?
   a) more than once a week b) once a week to once a month c) less than once a month d) never

10. Is there anyone in your community, other than your spouse or relatives on whom you can count for help if you should need it?
    a) no b) yes, but very little help c) yes, there is someone who would help some d) yes, there is someone who would do everything possible

11. Is your father still living?
    a) yes b) no

12. Is your mother still living?
    a) yes b) no

13. If both parents are living, do they live together?
    a) yes b) no

14. If No, how old were you when they separated or when one died?
    a) 0-5 years b) 6-12 years c) 13-20 years d) 21-30 years e) over 30 years

15. How many other children were you actually brought up with?
a) 1-2 b) 3-4 c) 5-7 d) 8-10 e) none

16. What was your place among them?
a) first b) last c) 2-4 d) 5-9

17. How many relatives (terms of families), other than parents and brothers and sisters, lived in the same home or community with you when you were growing up? a) none b) 1-5 c) 6-10 d) greater than 10

18. Compared to other families you know, how would you rate your own family for closeness? a) very close b) fairly close c) sort of distant d) very distant

19. How old were you when you left home?
a) am still living with them b) live with them in summers c) 10-15
d) 16-20 e) 21-28

20. When you were a child did you have some type of formal religious education?
a) yes b) no

21. How often do you now attend church, synagogue or chapel?
a) never b) once a week c) once a month d) few times a year

22. How important in general is religion to you even if you do not attend church?
a) very important b) somewhat important c) no importance

23. Do you believe that your religion helps you cope with problems?
a) definitely yes b) probably yes c) doubtful d) probably not e) no

Questions 24-26 apply if you are married. If you are not, continue with question 27.

24. Considering everything, marriage has been for you
a) very happy b) about average c) somewhat unhappy d) extremely unhappy

25. Has your marriage brought you many disappointments?
a) none b) only a few c) some d) a lot

26. Are you satisfied with your spouse?
a) perfectly b) well satisfied c) satisfied d) little bit dissatisfied e) dissatisfied

27. Do you believe that if you really want to do something you will usually be able to find a way to do it? a) definitely yes b) probably yes c) uncertain d) probably no e) no

28. How often are you bothered by loneliness or homesickness?
    a) never b) hardly ever c) sometimes d) most of the time

29. How easily do you adjust to sudden or unexpected change?
    a) very easily b) quite easily c) fairly easily d) some difficulty
    e) great difficulty

30. When you get angry do you usually get over your anger
    a) very quickly b) quite quickly c) sulk a bit d) sulk a lot
    e) hold a grudge

31. Are you usually a) trusting b) sort of trusting c) sort of suspicious d) suspicious

Have you answered all the questions?

Thank you for assisting with this health-related research and this information will be confidential between you and the researchers.

References

1. Yashizo, T. Air Pollution and Chronic Bronchitis, Osaka Univ. Med. J. 20: 10, 1968.
2. Mork, T. A Comparative Study of Respiratory Disease in England and Wales and Norway. Norwegian University Press, Oslow, 1962.
3. Petrilli, F.L., G. Agnese, and S. Kanitz. Epidemiologic Studies of Air Pollution Effects in Genoa, Italy. Arch. Environ. Health 12: 733, 1962.
4. Bates, D.V., C.R. Woolf, and G.I. Paul. Chronic Bronchitis: A Report on the First Two Stages of the Coordinated Study of Chronic Bronchitis in the Department of Veterans Affairs, Canada. Med. Serv. J. Can., 18: 211, 1962.
5. Neri, L.C., C.J.R. Pearson, W. Litven, and S.L. Green. Prevalence of Chronic Respiratory Disease and Possible Determinants in the Cities of Ottawa and Sudbury, Ontario. Report of Department of Epidemiology, Laboratory Centre for Disease Control, Health Protection Branch, Health, and Welfare, Canada, Ottawa, Ontario, 1976.
6. Chapman, R.S., C.M. Shy, J.F. Finklea, D.E. House, H.E. Goldberg and C.G. Hayes. Chronic Respiratory Disease in Military Inductees and Parents of School Children. Arch. Environ. Health 27: 138, 1973.

7. Bates, D.U., C.A. Gordon, G.I. Paul, R.E.G. Place, D.P. Snidal, and C.R. Woolf. Chronic Bronchitis. Report on the Third and Fourth Stages of the Coordinated Study of Chronic Bronchitis in the Department of Veterans Affairs, Canada. Med. Serv. J. Canada, 22: 5, 1962.

8. Ferris, B.G., Jr. and D.O. Anderson. Epidemiological Studies Related to Air Pollution: A Comparison of Berlin, New Hampshire and Chilliwack, British Columbia. Proc. Roy. Soc. Med. 57: 979, 1964.

9. Winkelstein, W., Jr. and S. Kantor. Respiratory Symptoms and Air Pollution in an Urban Population of Northeastern United States. Arch. Environ. Health, 18: 760, 1969.

10. Comstock, G.W., R.W. Stone, Y. Sakai, T. Matsuya, and J.A. Tonascia. Respiratory Findings and Urban Living. Arch. Environ. Health 27: 143, 1973.

11. Speizer, F.E. and B.G. Ferris, Jr. Exposure to Automobile Exhaust. I. Prevalence of Respiratory Symptoms and Disease. Arch. Environ. Health 26: 313, 1973.

12. Speizer, F.E. and B.G. Ferris, Jr. Exposure to Automobile Exhaust. II. Pulmonary Function Measurements. Arch. Environ. Health 26: 319, 1973.

13. Dosman, J., F. Bode, J. Urbanetti, R. Martin, and P.T. Macklem. The Use of a Helium-Oxygen Mixture During Maximal Expiratory Flow to Demonstrate Obstruction in Small Airways in Smokers. J. Clin. Invest. 55: 1090, 1975.

14. Antic, R. and P.T. Macklem. The Influence of Clinical Factors on Site of Airway Obstruction in Asthma. Am. Rev. of Resp. Disease 114: 851, 1976.

15. Chan-Yeung, M., R. Abboud, M.S. Tsao, and L. Maclean. Effects of Helium on Maximal Expiration Flow in Patients with Asthma Before and During Induced Bronchoconstriction. Am. Rev. of Resp. Disease 113: 433, 1976.

16. Hainline, A. Jr. "Methemoglobin." In Standard Methods of Clinical Chemistry (Vol. 5), Meites, S., Ed Academic Press, New York, 1965, pp. 143-157.

17. Peuler, J.D. and G.A. Johnson, Clin. Res. 23: 474, 1975.

18. Cohen, E.L., C.E.Grun, J.W. Conn, W.M., Jr., R.B. Guyer, D.C. Kem, and C.P. Lucas. J. Lab. Clin. Med. 77: 1025, 1971.

19. Foster, L.B. and R.T. Dunn. Clin. Chem. 20: 365, 1974.

20. United States Environmental Protection Agency. Office of Air Waste Management, Research Triangle Park, NC 27711. Monitoring and Air Quality Trends Report, 1972, EPA-450/173-004, December, 1973.

21. Smith, F., A.C. Nelson, Jr. Guidelines for Development of a Quality Assurance Program for Research Method for the Determination of Suspended Particulates in the Atmosphere (High Volume Method). U.S. EPA, Division of Quality Assurance and Environmental Monitoring, April, 1973.

22. West, P.W. and G.C. Gaeke. Fixation of Sulfur Dioxide as Sulfitomeraurate III and Subsequent Colorimetric Determinations. Anal. Chem. 28: 1816, 1956.

23. Scaringelli, F.P., B.E. Saltzman, and S.A. Frey. Spectrophotometric Determination of Atmospheric Sulfur Dioxide. Anal. Chem. 39: 1709, 1967.

24. Federal Register, Vol. 38, No. 110, Fri., June 8, 1973, pp. 15174.

25. Christie, A.A., R.G. Lidzey, and D.W.F., Radford. Analyst 95: 519, 1970.

26. Federal Register, Vol. 36, No. 84, Fri., April 30, 1971, pp. 8186-8193.

27. Blackburn, H., A. Keys, E. Simonson, P. Rautaharju, and S. Punsar. The Electrocardiogram in Population Studies. Circulation 21: 1160-1175, 1960.

28. T.H. Holmes and R.H. Rahe. The Social Readjustment Rating Scale. J. Psychosom. Res. 11: 213-18, 1967.

29. Taylor, R.M. and R.H. Johnson. Taylor-Johnson Temperament Analysis. Psychological Pub., Inc., Los Angeles, Calif., 1967.

30. Nuckolls, K.B., J. Cassel, and B.H. Kaplan. Psychosocial Assets, Life Crises and the Prognosis of Pregnancy. Am. J. Epidemiol. 95: 431-41, 1972.

31. Mantel, N. and W. Haenszel. Statistical Aspects of the Analysis of Data from Retrospective Studies of Disease, J. Nat. Cancer, Inst. 22: 719, 1959.

32. Scandanavian Committee on ECG Classification. Acta Medica Scandinavia Suppl. 481: 1-26, 1967.

33. Ducimetiere, E.P. and J.L. Richard. Reproducibility of Analysis of the Electrocardiogram in Epidemiology Using the Minnesota Code. Brit. J. Prev. Soc. Med. 24: 197-200, 1970.

34. Ivanova, S.A. Application of Minnesota ECG Classification Code System Amplified by Some Quantitative Code Signs in Diagnostics of Acquired Vitium Cordis and Early Phase of Ischemic Heart Disease. Adv. Cardiol. 19: 257-258, 1977.

35. Elgrishi, I., P. Ducimetiere, and J.L. Richard. Reproducibility of Analysis of the Electrocardiogram in Epidemiology Using the Minnesota Code. Brit. J. Prev. Soc. Med. 24: 197, 1970.

36. Higgins, I.T.T., W.B. Kannel, and T.R. Dawber. The Electrocardiogram in Epidemiological Studies. Brit. J. Prev. Soc. Med. 19: 53, 1965.

37. Ferris, B.G. Tests to Assess Effects of Low Levels of Air Pollutants on Human Health. Arch. Environ. Health 21: 553-558, 1970.

38. Blackburn, H. The Exercise Electrocardiogram in Diagnosis. Cardiology 62: 190-205, 1977.

39. Willems, J., J. Dranlans, and H. DeGust. An Appraisal of the Minnesota Code in "Inferior" Myocardial Infarction. J. Electrocard. 3: 147-154, 1970.

40. Pyorala, K. and E. Kentala. Disappearance of Minnesota Code Q-QS Patterns in the First Year After Myocardial Infarction. Ann. Clin. Res. 6: 137-141, 1973.

41. Rautahar, P.M. Use and Abuse of Electrocardiographic Classification Systems in Epidemiologic Studies. Eur. J. Cardiol. 8: 155-171, 1978.

42. Ishikawa, K. Correlation Coefficients for Electrocardiographic and Constitutional Variables. Amer. Heart J. 92: 152-161, 1976.